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APOLLO/SKYLAB SUIT PROGRAM

Management Systems Study

Volume II

Cost Analysis

Contract NAS 9-6100

April 30, 1974

ILC INDUSTRIES, INC.

(NASA-CR-147587) APOLLO/SKYLAB SUIT PROGRAM MANAGEMENT SYSTEMS STUDY. VOLUME 2: COST ANALYSIS (ILC Industries, Inc., Dover, Del.) 58 p HC $4.50 CSCL 06K

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VOLUME II

TITLE:

Cost Analysis

SECTION OUTLINE:

- Introduction
- Objective
- Approach
- Discussion
  - Analysis of Historical Data
    - Cost
    - Manhours
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      - Change Activity
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  - Figure 3.7.1 Program Office
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INTRODUCTION:

In early 1965 ILC Industries was awarded Contract NAS 9-5332. This initial procurement encompassed Phase I of the Apollo EMU Garment Program. The contract was performed through 1965 and 1966 with ten (10) Model A5L garments being delivered at a value of $1,950,149. This contract is not included as part of this study but mentioned here only for background information.

Subsequently, in June 1966, ILC Industries was awarded Contract NAS 9-6100 "Apollo EMU Garment CEI Program, Phases II and III". This follow-on procurement established Schedules I and II. Schedule I included the design, fabrication, and delivery of garment CEI's of the Apollo EMU. Schedule II provided for field support and sustaining engineering at the field sites and the contractor's facility.

The initial procurement established a contract value of $13,426,000 for Schedule I; $1,176,600 of which was the maximum attainable fee. Through the progress of Schedule I, additional procurements, changes and extensions to the contract period increased the contract value for administrative closeout to $25,990,183 of which $1,884,295 was fee and award fee. The Schedule I period of performance ran from June 1966, through March 1970. Under Schedule I, 115 PGA's with spares were delivered; twenty-five (25) Model A6L, and ninety (90) Model A7L. These garments were used as early Apollo training suits and for Apollo missions 7 through 14.

Schedule II was established with a contract value of $747,158; $38,908 being fixed fee. During the period of performance of Schedule II, which ran from June 1966, through December 1969, additional manpower and extensions were authorized. The contract value for administrative closeout grew to $5,740,888 of which $370,088 was fixed fee.

Schedule III was established in January 1969, and provided initially for the fabrication and delivery to Marshall Space Flight Center of eight (8) Class III PGA's resembling as close as possible the A7L EV PGA. Contract value was $158,034. Subsequent modifications extended

Schedule III to include maintenance and repair of the eight (8) PGA's at MSFC. The final contract value was $203,034 including $18,300 fee. This schedule will not be included in details listed in this study but is cited here for background information.

In November 1969, effort was initiated on Schedule IV. The procurement was accomplished under Supplemental Agreement 333S. This procurement included design, fabrication, and delivery of 36 A7L pressure garment assemblies and field support through the period ending December 31, 1971. The contract value was $13,004,841, including a maximum fee attainable of $1,046,367. Subsequent to SA 333S, CCA 1000 was approved authorizing design and fabrication of the Model A7LB suit. Not including Design Verification Test and Qualification Test articles, two (2) additional A7LB suits were added to contract quantities. The suits procured under SA 333S were revised to be six (6) Model A7L's and thirty (30) Model A7LB's. These suits were to support Apollo Missions 15 through 17.

Effective March 1, 1971, a major procurement under Supplemental Agreement 433S added 57 A7LB PGA's to the program and extended the contract performance period including field support through December 31, 1973. This extension was added to provide for Skylab mission requirements. SA 433S plus SA 333S and other intervening changes and new procurements increased the Schedule IV contract value to $28,771,407 including a maximum fee of $2,250,827.

Following SA 433S, two significant program changes took place. Supplemental Agreement 565S deleted 18 suits planned for Apollo 18 and 19 from the program in October 1972. In March 1973, nine (9) suits with spares were added to the program for the ASTP mission. Including these two supplmeental agreements, other changes and new procurements, the Schedule IV contract value on December 31, 1973, stood at $30,925,582, which included $2,459,761 of fee and award fee. Actual expenditures through December 31, 1973, were $29,626,710; $2,220,561 being fee.

Through the performance of the entire contract, excluding Schedule III, ILC delivered 201 pressure garment assemblies and associated spares; provided management, design, and mission support engineering for all aspects of the program; and supported field operations. Field support in the amount of 7950.7 man months was provided.

This section will analyze the facts presented above and provide a detailed examination of the cost history associated with this contract. A hindsight view will also be given to the business management system employed in the monitoring and control of the cost, budgeting, and reporting mechanisms associated with this contract. Recommendations for simplified and improved methods will be presented.

OBJECTIVE:

This section is a study of the business management methods employed in the performance of the Apollo/Skylab Suit Program - Contract Number NAS 9-6100. This report will deal with the data as accumulated over the span of the contract as well as the methods used to accumulate the data. Management methods associated with the monitoring and control of resources applied towards the performance of the contract will also be studied and recommended upon. The primary objective of this report, however, is the compilation, analysis, and presentation of historical cost performance criteria. Cost data will be depicted for all phases of the Apollo/Skylab program in common, meaningful terms, whereby the data may be applicable to future suit program planning efforts.

A secondary objective of this report is to develop and present a skeleton business management system to define a recommended work breakdown structure/cost collection method for future suit programs. The recommended business management system would provide cost data capable of providing historical criteria as developed in the primary objective as well as being compatible with internal management requirements of the typical suit contractor. It is assumed that the cost data criteria established in the primary

objective would be the basic reporting skeleton to the government.

APPROACH:

Approach to Analysis of Cost Data

Since the inception of the Apollo Suit Program (Contract No. NAS 9-6100), the cost collection philosophy applied to the program has varied at different periods of time. This changing philosophy has left the cost history at the end of the program in a disoriented form for extracting a common string of meaningful data through the different phases of the contract performance. With the goal in mind to achieve a common baseline of data, NASA and ILC personnel, in a joint meeting, established the meaningful terms for the different major tasks which would relate to all suit development and production efforts.

These major tasks were then discussed in relation to the cost collection methods employed over the span of the contract and also in relation to the different suit program applications which were included in the scope of the contract. From this, a rationale was developed which defines the major functions associated with each suit application phase and further defines the portions of the cost collection data which are applicable to each function and suit application. Table I under "Analysis of Historical Data" is a matrix which graphically depicts the above rationales for costs. Later in the Manhours section of "Analysis of Historical Data" another matrix graphically depicting the rationale for segregation of manhours into phases and major divisions of labor is shown. Cost and manhours data was then accumulated in terms of the matrices and analysis data in the forms of charts and tables were extracted. A major emphasis of this data compilation and analysis was establishing unit suit costs for the program applications of the suits for the major functions and phases of the program.

APPROACH TO BUSINESS MANAGEMENT SYSTEM:

Having a view of the problems involved in the compilation of data in the required format for the above analysis as well as having experienced the application of redundant reporting and internal control systems during the performance of the contract, the work breakdown structure/cost collection system was reviewed for possible changes and improvements. The criteria established in the analysis of cost data was used as the basic skeleton for establishment of the major tasks and end items of the work breakdown structure forming the "X" axis of the function/task matrix. Realizing that the typical suit contractor will probably be a small concern with limited cost accounting capabilities built into their system, an organizational alignment suitable to a typical suit contractor was established as the "Y" axis of the function/task matrix. The recommended function/task matrix is shown in Exhibit I.

ANALYSIS OF HISTORICAL DATA

COST

GENERAL:

Cost data has been compiled from Contract NAS 9-6100 Schedules I, II and IV beginning with the inception of the program in early 1966 through the completion of the program in December 1973. Schedule III information has been excluded. Projected costs for Contract NAS 9-13698 ASTP Support have also been added to complete the cost picture in relating the ASTP to the other phases. NAS 9-13698 encompasses the time period from January 1974 through August 1975.

In a joint meeting between NASA and ILC, certain criteria were established as the significant criteria which are typical of suit programs and which provide the most meaningful data base to review and analyze cost in a suit program. It was first determined that the contract performance was actually divisible into four phases:

- Apollo 7 through 14
- Apollo 15 through 17
- Skylab
- ASTP

The phases were then further divided into major functions. The major functions are:

- Production
- Development
- Mission Support
- Program Management
- Field Support
- Retrofit and Repair
- Spares

All costs over the entire span of the program are divided into the phases and major functions per the rationales presented in Table 1. All costs are presented in terms of major cost elements; the cost elements being:

- Labor
- Material - Includes Material and Subcontract
- Other Direct Costs - Includes other direct and travel
- Burden
- G & A
- Fee

COMMENTS ON ANALYSIS OF COST:

Tables II A through E present all phases of the program and the total program segregated into major functions showing expenditures by cost element for each. Figures 2 a through e graphically present this information in terms of percentages of cost by function for each phase and the total contract. Table III is a summary of total costs by major function for each phase. Table IV A is a further extension of this summary where total costs of each major function are reduced to cost per unit and percentage of cost of each function by phase.

Table IV B uses the same data as Table IV A but the number of units in the Apollo 15-17 and Skylab phases is adjusted to reflect useage of certain suits in more than one mission. This reapplication of factors has the effect of showing unit suit costs in relation to total mission assignment. Figures 1 a through e present the percentage of cost each major function represented in each phase.

During the Apollo 7-14 phase, performed at essentially a 1/3 delivery rate (one suit every three days) in the early part and then to a 1/5 rate to conclude the phase, the large number of suits and the rapid delivery rate had the effect of reducing the percentages of costs expended on functions other than production. Functions other than production and spares were level of effort oriented and not sensitive to production levels and delivery rate changes. Production costs were also significantly higher because during this period contract changes effecting production, in-line retrofits, production holds and delays were accumulated

as production costs. These factors swelled the total production costs and increased both the percentage of cost and the cost per unit inordinately in relation to what the actual suit cost might have been had not these additional costs been incurred.

The Apollo 15-17 phase was performed at a nominal 1/5 delivery rate. The effect of a short period of activity with a rapid delivery rate can be seen in this phase quite readily by the relationship of percentages of costs attributed to production versus the other functional areas. The extended launch centers for these flights also had the effect of showing increased field support costs per unit during this phase.

The Skylab phase performed also at a 1/5 rate saw the production as well as the total unit suit cost at the lowest level for the entire contract performance. This is so because the change level was greatly restricted and in-line retrofit changes (production costs) did not occur. The suit remained fairly stable during this period and no significant technical problems occurred.

In contrast to the Skylab phase, the ASTP phase was an extended phase with few suits being delivered at a 1/10 rate. In this phase the low quantity of suits and the extended delivery rate dictated the performance of the production on a station concept whereby individual fabricators were assigned certain elements of the fabrication process. This produced delays and gaps in the flow causing the fabricators to work at a very inefficient pace. Production costs are also significantly higher because of the level of support retained in manufacturing engineering (a production cost) for program contingency commitments. The level retained was much lower than previous phases but the quantity of suits was also greatly reduced, thereby, placing an inordinate burden on each suit in comparison to other phases. Field support unit costs are also exceptionally high because field operations are sustained through August 1975.

Spreading this long period of cost on a unit basis for such few suits distorts the relationship appreciably.

Table V is a tabular summary of total cost by phase in elements of cost. Figures 2 a through e depict this data in graph form.

The notable relationships to be derived from this comparison are: 1) the steady percentage level which labor retains through all phases with the exception of the ASTP phase. Previous statements concerning labor on the ASTP phase coupled with the use of much GFE material in fabrication are the prime causes of this variation; 2) following completion of the Apollo 7-14 phase, material costs levelled to a steady percentage of costs on the order of approximately 10%. During the Apollo 7-14 phase, subcontract costs were high, particularly costs related to LTV Aerospace and Airlock, Inc. (See Table IX Subcontract Costs by Subcontractor by Year).

RATIONALE FOR SEGREGATING COSTS BY MAJOR FUNCTION BY PHASE

NO. OF SUITS PHASE	115 APOLLO 7-14		40 APOLLO 15-17		37 SKYLAB	9 ASTP
	SCHEDULE I	SCHEDULE II	SCHEDULE IVA	SCHEDULE IVB	SCHEDULES IVA & IVB	SCHEDULE IVB & NAS 9-13698
PRODUCTION	-CEI COSTS - Incl. only production type labor i.e. sewers, machinists, etc. (Eng'g, Draft, 50% Tech, Sec'y, Photo to Develop). - Manufacturing Eng'g - Inspection Portion of Quality Assurance.	N/A	- Project 822 (Less Mission Support excepting Mfg. Eng'g) Nov 69 thru May 71	-Project 822 & 832 (Less Mission Support excepting Mfg. Eng'g) Prorated to Apollo/ Skylab on basis of suits delivered during period (13/31 Apollo) Jun 71 thru Jun 72	-Project 822 & 832 (Less Mission support excepting Mfg. Eng'g) prorated to Apollo/Skylab on basis of suits delivered during period (18 of 31 Skylab) Jun 71 thru Jun 72 -Project 832 (Less Mission support excepting Mfg. Eng'g) Jul 72 thru Dec 72	-Project 842 less estimated spares included in production run. Apr 73 thru Dec 73 -Manufacturing Engineering (40-840) Jan 73 thru Dec 73
DEVELOPMENT	-Includes Quality Assurance less inspection; project & system Eng'g; & Development portion of CEI costs inception thru Sep 68 (per schedule below)	-Sustaining Engineering	- Projects 820, 821, 823, 828 & 829 less CCA 1000B inception thru May 71	-50% of 830, 831, 833 & 838 - Oct 71 thru Feb 72 (Apollo 16 Problems)	-CCA 1000B Mar 71 thru May 71 -100% of Projects 820, 821, 823 & 828 Jun 71 -100% of Projects 830, 831, 833 & 838 Jul 71 thru Sep 71 -50% of Projects 830, 831, 833 & 838 Oct 71 thru Feb 72 -100% of Projects 833 & 838 Mar 72 thru Dec 73	N/A
MISSION SUPPORT	-Prorate per schedule Oct 68 thru Dec 69 Miss Supp / Development Project Eng'r 75% / 25% Systems Eng'r 25% / 75% QA&R 50% / 50%	N/A	-Eng'g; QA&R; and Admin. portion of project 822 Nov 69 thru Jun 71	-Eng'g; QA&R; and Admin. portion of projects 822 & 832 Jul 71 thru Dec 72	- Project 840 Jan 73 thru Apr 73 - Project 840 May 73 thru Dec 73 Skylab / ASTP Engineering 50% / 50% QA&R 30% / 70% - Project 830 & 831 Mar 72 thru Dec 72	-Project 846:Projection of call tasks and age life testing -Project 840 May 73 thru Dec 73 ASTP / Skylab Engineering 50% / 50% QA&R 70% / 30%
PROGRAM MANAGEMENT	- Program Management Task	- Dover On-Site costs segregated; eng'r, techs & secy-Program Mgmt/Balance to Maintenance & Repair	-Prorata share of project 819 based upon Apollo expenditures. -Dover portion of field support (project 826)	-Prorata share of project 839 based upon Apollo expenditures	- Prorata shares of Projects 819 & 839 based on Skylab expenditures	-Prorata share of proj. 839 based upon ASTP expenditures -Dover Management portion ASTP field support Jan 74 thru Aug 75

TABLE I

RATIONALE FOR SEGREGATING COSTS BY MAJOR FUNCTION BY PHASE

NO. OF SUITS PHASE	115 APOLLO 7-14		40 APOLLO 15-17		37 SKYLAB	9 ASTP
	SCHEDULE I	SCHEDULE II	SCHEDULE IVA	SCHEDULE IVB	SCHEDULE IVB	SCHEDULE IVB & NAS 9-13698
IELD SUPPORT	N/A	-Field Support - Offsite Task	-Project 826 less Dover portion Nov 69 thru Jun 71	- Project 836 Jul 71 thru Dec 72	- Project 836 Jan 73 thru Dec 73	- Project 846 Jan 74 thru Aug 75 (Projected Costs)
ETROFIT & EPAIR	N/A	-Dover On-Site Costs- Segregated (See Program Management)	-Projects 824 & 827	-Projects 834 & 837 Jul 71 thru Nov 72 (Apollo 17 Launch Dec 7, 1972)	- Projects 834 & 837 Dec 72 thru Dec 73	N/A
PARES	- Spares Task	N/A	-Project 825	-Project 835 Jul 71 thru Oct 72	- Project 835 Nov 72 thru Oct 73	- Project 835 Nov 73 thru Dec 73 - Estimated spares during ASTP production - Estimated Spares Procurement - ASTP follow-on

TABLE I

SUMMARY - MAJOR FUNCTIONS ALL PHASES

BY COST ELEMENT

	Production	Development	Mission Support	Program Mgmt.	Field Support	Retrofit & Repair	Spares	Total
Labor	4,096	3,494	2,252	2,868	5,505	296	210	18,721
Material	7,940	614	34	717	37	230	1,369	10,941
Other Direct	812	311	40	1,187	574	4	2	2,930
ST	12,848	4,419	[illegible],326	4,772	6,116	530	1,581	32,592
Burden	4,671	4,086	2,517	3,265	1,414	344	239	16,536
G & A	2,981	1,438	975	1,400	1,511	170	300	8,775
ST	20,500	9,943	5,818	9,437	9,041	1,044	2,120	57,903
Fee	1,674	791	499	781	720	87	171	4,723
TOTAL	22,174	10,734	6,317	10,218	9,761	1,131	2,291	62,626

TABLE IIA

SUMMARY - MAJOR FUNCTIONS - APOLLO 7-14

BY COST ELEMENT

	Production	Development	Mission Support	Program Mgmt.	Field Support	Retrofit & Repair	Spares	Total
Labor	2,311	2,141	350	1,280	1,763	41	121	8,007
Material	6,126	261	22	717	34	81	1,094	8,335
Other Direct	607	260	33	594	167	-	-	1,661
ST	9,044	2,662	405	2,591	1,964	122	1,215	18,003
Burden	2,676	2,467	406	1,476	441	46	141	7,653
G & A	1,751	772	109	606	356	25	202	3,821
ST	13,471	5,901	920	4,673	2,761	193	1,558	29,477
Fee	1,050	440	82	357	190	13	122	2,254
TOTAL	14,521	6,341	1,002	5,030	2,951	206	1,680	31,731

TABLE IIB

SUMMARY - MAJOR FUNCTIONS - APOLLO 15-17

BY COST ELEMENT

	Production	Development	Mission Support	Program Mgmt.	Field Support	Retrfit & Repair	Spares	Total
Labor	1,005	979	1,150	1,146	2,669	228	66	7,243
Material	1,017	320	-	-	3	134	231	1,705
Other Direct	150	45	-	388	277	-	2	862
ST	2,172	1,344	1,150	1,534	2,949	362	299	9,810
Burden	1,190	1,205	1,281	1,315	668	268	73	6,000
G & A	655	510	482	564	738	126	76	3,151
ST	4,017	3,059	2,913	3,413	4,355	756	448	18,961
Fee	336	288	237	303	372	64	39	1,639
TOTAL	4,353	3,347	3,150	3,716	4,727	820	487	20,600

TABLE IIC

SUMMARY - MAJOR FUNCTIONS - SKYLAB

BY COST ELEMENT

	Production	Development	Mission Support	Program Mgmt	Field Support	Retrofit & Repair	Spares	Total
Labor	536	374	545	369	645	27	17	2,513
Material	769	33	-	-	-	15	33	850
Other Direct	48	6	7	177	53	4	-	295
ST	1,353	413	552	546	698	46	50	3,658
Burden	529	414	590	392	162	30	18	2,135
G & A	444	156	272	188	216	19	17	1,312
ST	2,326	983	1,414	1,126	1,076	95	85	7,105
Fee	226	63	128	103	99	10	9	638
TOTAL	2,552	1,046	1,542	1,229	1,175	105	94	7,743

TABLE IID

SUMMARY - MAJOR FUNCTIONS - ASTP

BY COST ELEMENT

	Production	Development	Mission Support	Program Mgmt	Field Support	Retrofit & Repair	Spares	Total
Labor	244	-	207	73	428	-	6	958
Material	28	-	12	-	-	-	11	51
Other Direct	7	-	-	28	77	-	-	112
ST	279	-	219	101	505	-	17	1,121
Burden	276	-	240	82	143	-	7	748
G & A	131	-	112	42	201	-	5	491
ST	686	-	571	225	849	-	29	2,360
Fee	62	-	52	18	59	-	1	192
TOTAL	748	-	623	243	908	-	30	2,552

TABLE IIE

TOTAL COSTS BY MAJOR FUNCTION BY PHASE (IN 000's)

	Apollo 7-14	Apollo 15-17	Skylab	ASTP	Total
No. of Suits	115	40	37	9	201
Functions					
Production	14,521	4,353	2,552	748	22,174
Development	6,341	3,347	1,046	-	10,734
Mission Support	1,002	3,150	1,542	623	6,317
Program Management	5,030	3,716	1,229	243	10,218
Field Support	2,951	4,727	1,175	908	9,761
Retrofit and Repair	206	820	105	-	1,131
Spares	1,680	487	94	30	2,291
TOTAL	31,731	20,600	7,743	2,552	62,626

TABLE III

APOLLO/SKYLAB NAS 9-6100

UNIT SUIT COSTS BY MAJOR FUNCTION BY PHASE

Major Function	Apollo 7-14 Total Cost	Apollo 7-14 No. of Units	Apollo 7-14 Cost Per Unit	Apollo 7-14 % of Cost	Apollo 15-17 Total Cost	Apollo 15-17 No. of Units	Apollo 15-17 Cost Per Unit	Apollo 15-17 % of Cost	Skylab Total Cost	Skylab No. of Units	Skylab Cost Per Unit	Skylab % of Cost	ASTP Total Cost	ASTP No. of Units	ASTP Cost Per Unit	ASTP % of Cost
Production	14,521	115	126	45.5	4,353	40	109	21.1	2,552	37	69	32.9	748	9	83	29.3
Development	6,341		55	19.9	3,347		84	16.3	1,046		28	13.3	-		-	-
Mission Support	1,002		9	3.2	3,150		79	15.3	1,542		42	20.0	623		69	24.4
Program Management	5,030		44	15.9	3,716		93	18.0	1,229		33	15.8	243		27	9.5
Field Support	2,951		26	9.4	4,727		118	22.9	1,175		32	15.2	908		101	35.7
Retrofit and Repair	206		2	0.7	820		21	4.1	105		3	1.4	-		-	-
Spares	1,680		15	5.4	487		12	2.3	94		3	1.4	30		3	1.1
TOTAL	31,731		277	100.0	20,600		516	100.0	7,743		210	100.0	2,552		283	100.0

TABLE IVA

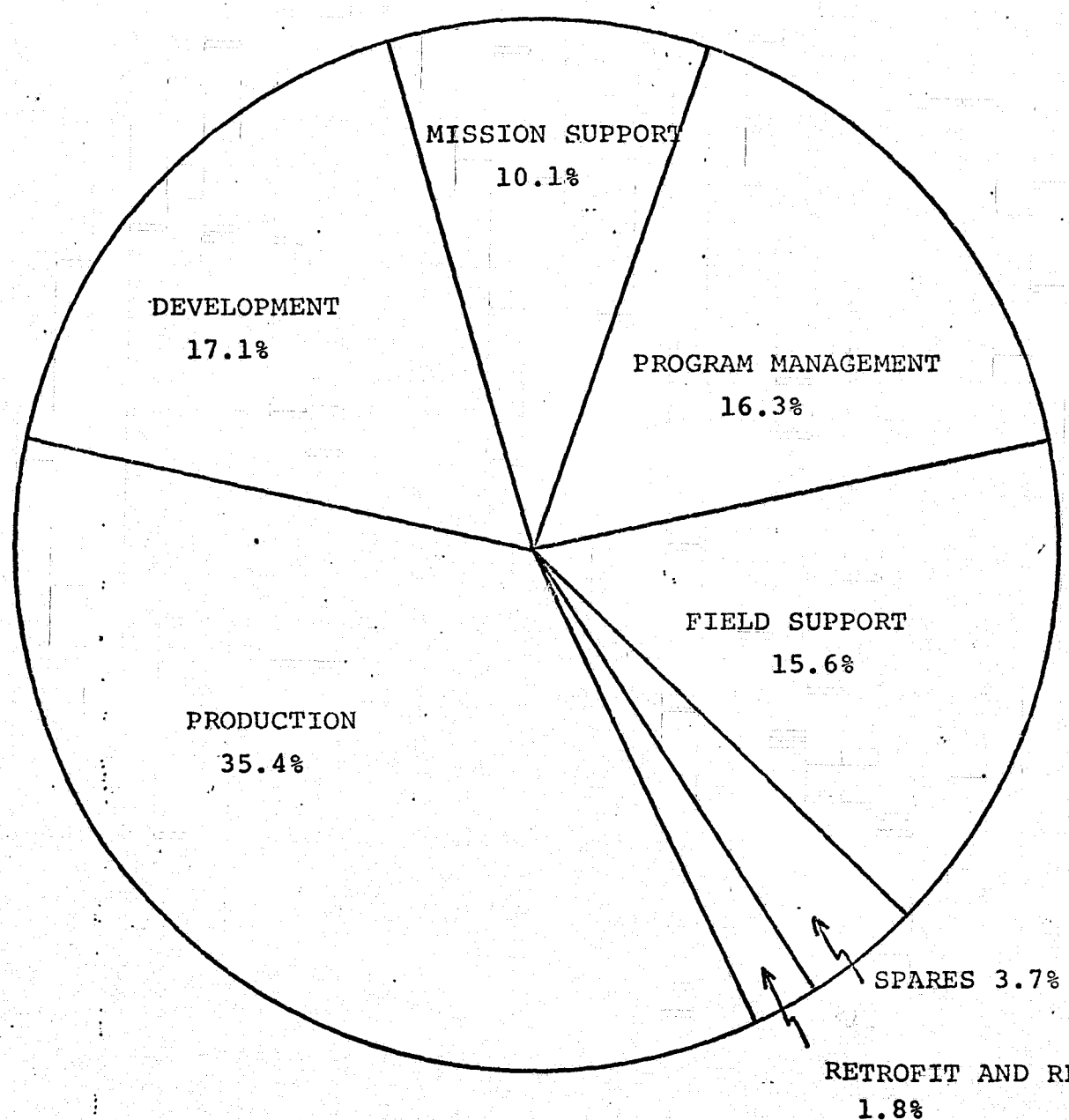
APOLLO/SKYLAB NAS 9-6100

UNIT SUIT COSTS BY MAJOR FUNCTION BY PHASE

(With Number of Units Adjusted for Reuse)

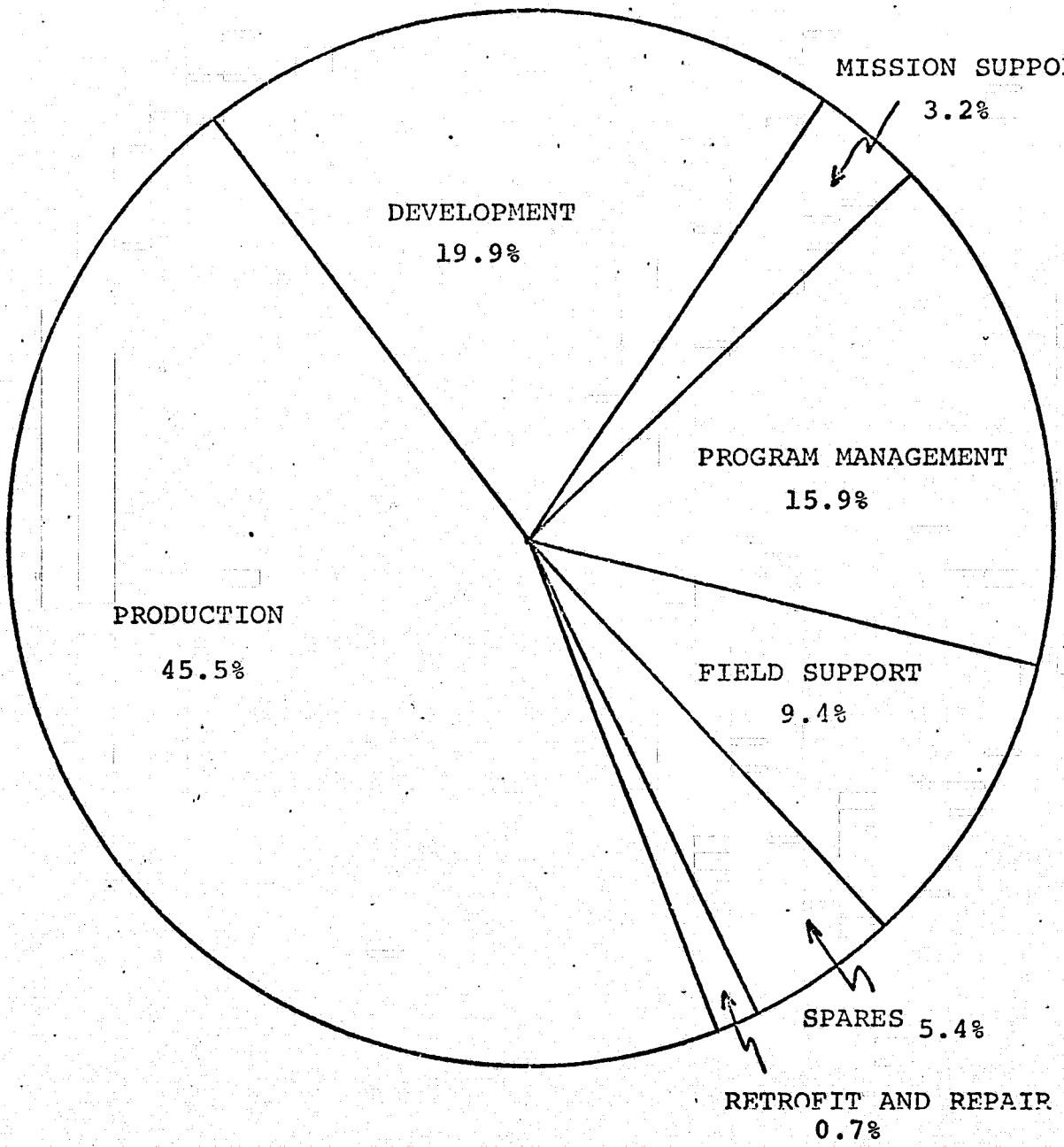
Major Function	Apollo 7-14				Apollo 15-17				Skylab				ASTP			
	Total Cost	No. of Units	Cost Per Unit	% of Cost	Total Cost	No. of Units	Cost Per Unit	% of Cost	Total Cost	No. of Units	Cost Per Unit	% of Cost	Total Cost	No. of Units	Cost Per Unit	% of Cost
Production	14,521	176	83	45.5	4,353	60	72	21.1	2,552	48	53	32.9	748	15	50	29.3
Development	6,341		36	19.9	3,347		56	16.3	1,046		22	13.3	-		-	-
Mission Support	1,002		6	3.2	3,150		53	15.3	1,542		32	20.0	623		42	24.4
Program Management	5,030		29	15.9	3,716		62	18.0	1,229		26	15.8	243		16	9.5
Field Support	2,951		17	9.4	4,727		79	22.9	1,175		24	15.2	908		61	35.7
Spares	1,680		10	5.4	487		8	2.3	94		2	1.4	30		2	1.1
Retrofit & Repair	206		1	0.7	820		14	4.1	105		2	1.4	-		-	-
TOTAL	31,731		182	100.0	20,600		344	100.0	7,743		161	100.0	2,552		171	100.0

TABLE IVB



NAS 9-6100 TOTAL CONTRACT
PERCENTAGE OF COST BY FUNCTION

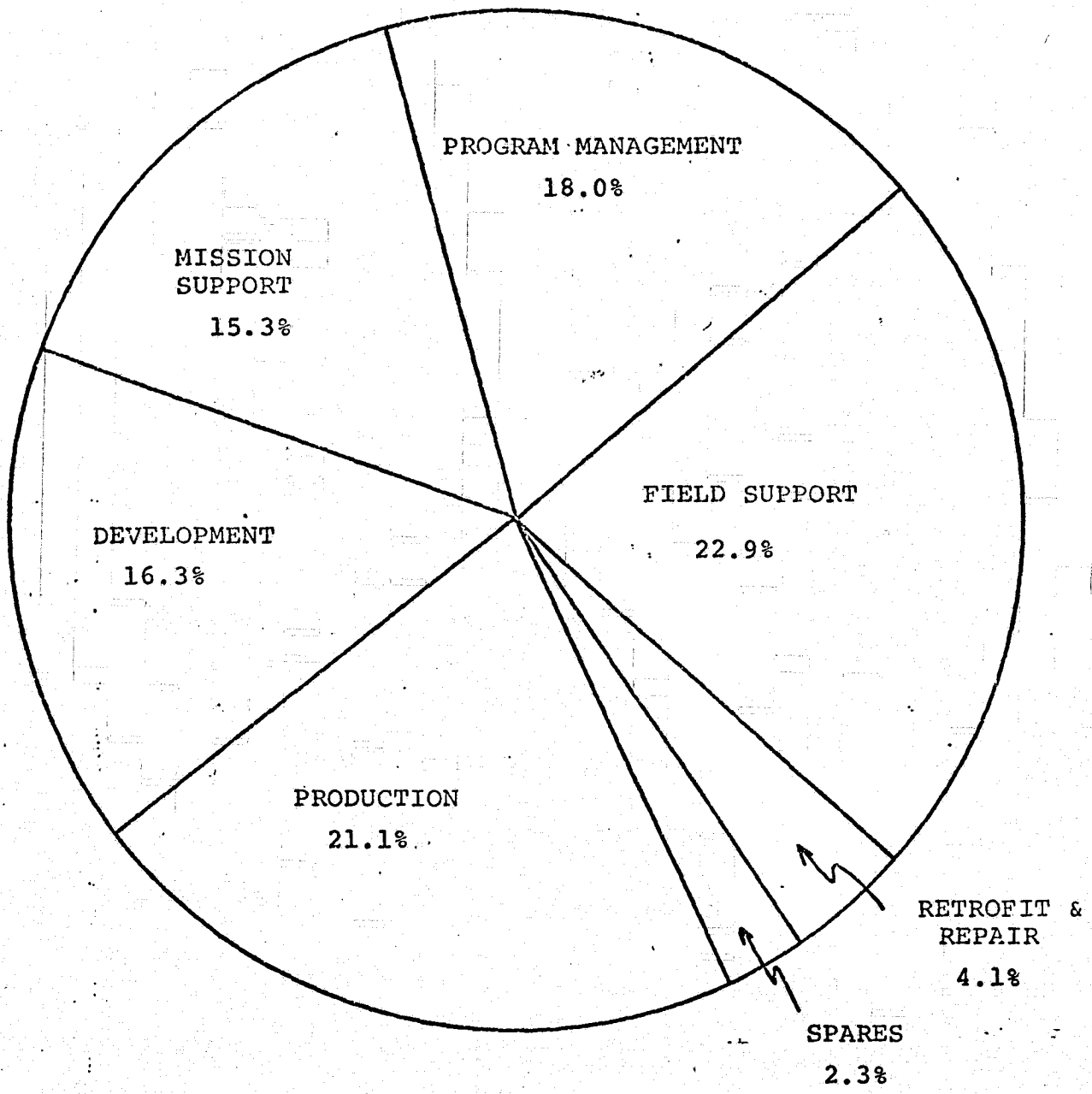
FIGURE 1a



NAS 9-6100 APOLLO 7-14 PHASE

PERCENTAGE OF COST BY FUNCTION

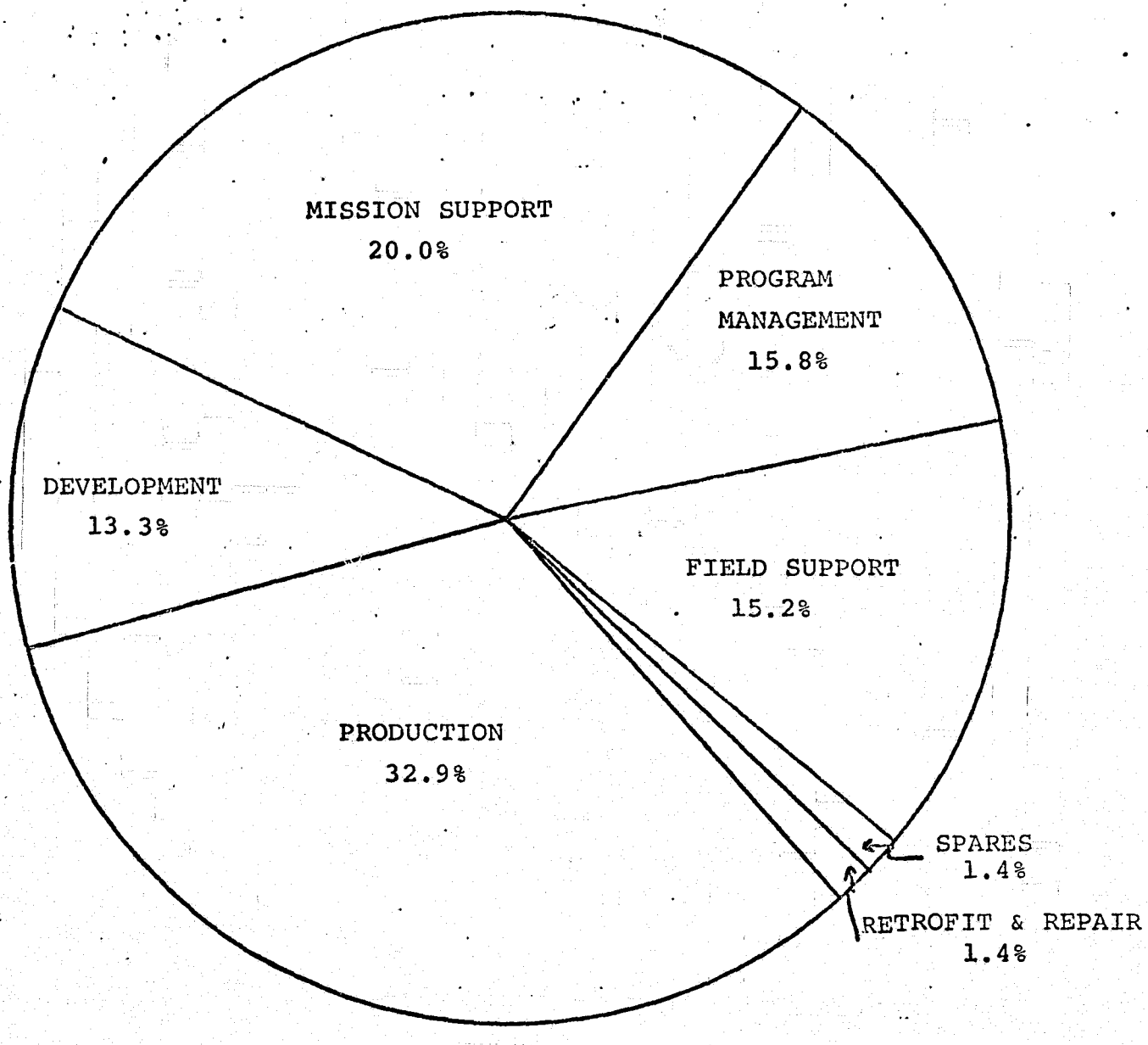
FIGURE 1b



NAS 9-6100 APOLLO 15-17 PHASE

PERCENTAGE OF COST BY FUNCTION

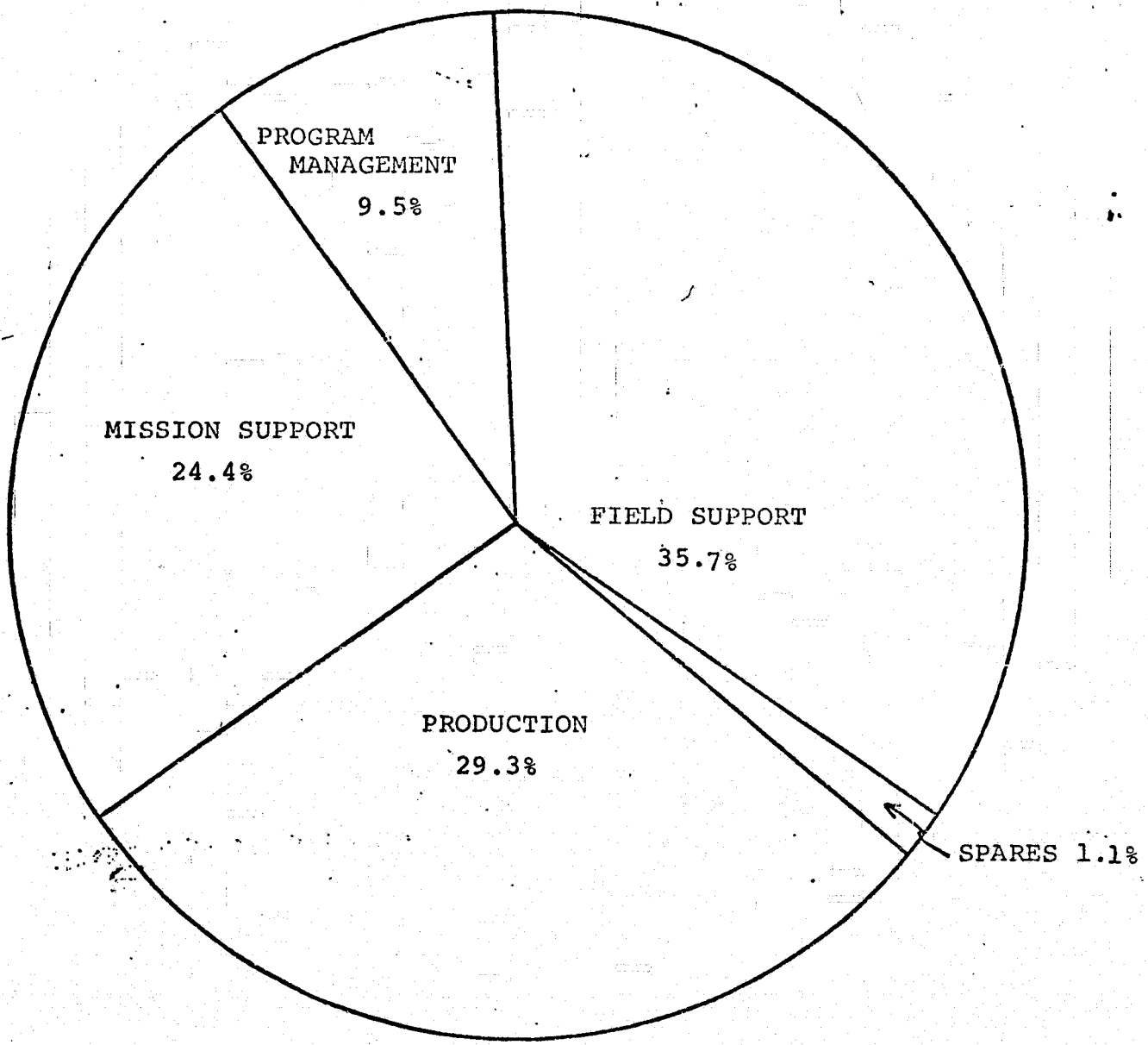
FIGURE 1c



NAS 9-6100 SKYLAB PHASE

PERCENTAGE OF COST BY FUNCTION

FIGURE 1d



NAS 9-6100 ASTP PHASE

PERCENTAGE OF COST BY FUNCTION

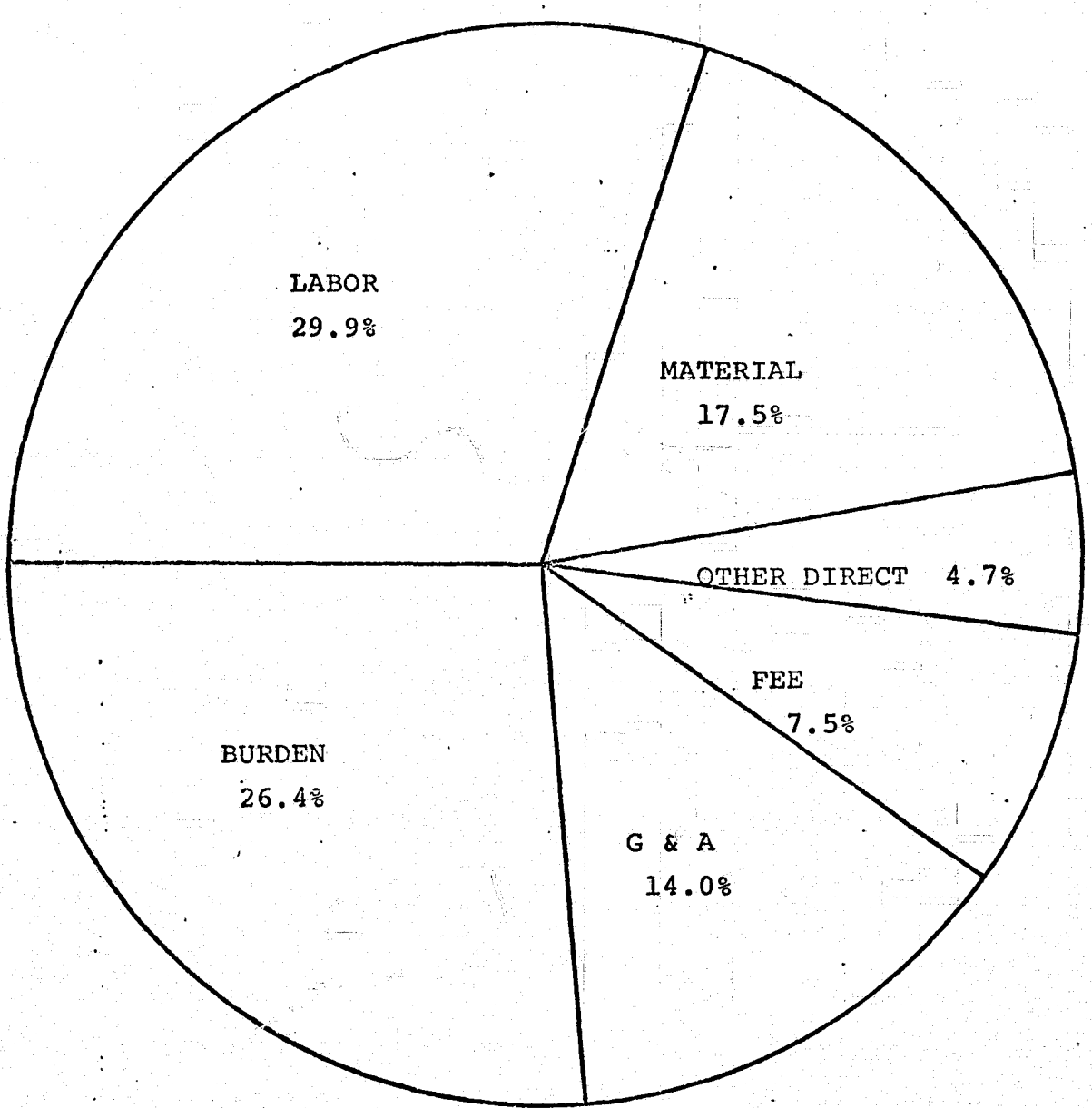
FIGURE 1e

PROGRAM COSTS BY PHASE

BY COST ELEMENT

	Apollo 7-14	Apollo 15-17	Skylab	ASTP	Total
Labor	8,007	7,243	2,513	958	18,721
Material	8,335	1,705	850	51	10,941
Other Direct	1,661	862	295	112	2,930
ST	18,003	9,810	3,658	1,121	32,592
Burden	7,653	6,000	2,135	748	16,536
G & A	3,821	3,151	1,312	491	8,775
ST	29,477	18,961	7,105	2,360	57,903
Fee	2,254	1,639	638	192	4,723
TOTAL	31,731	20,600	7,743	2,552	62,626

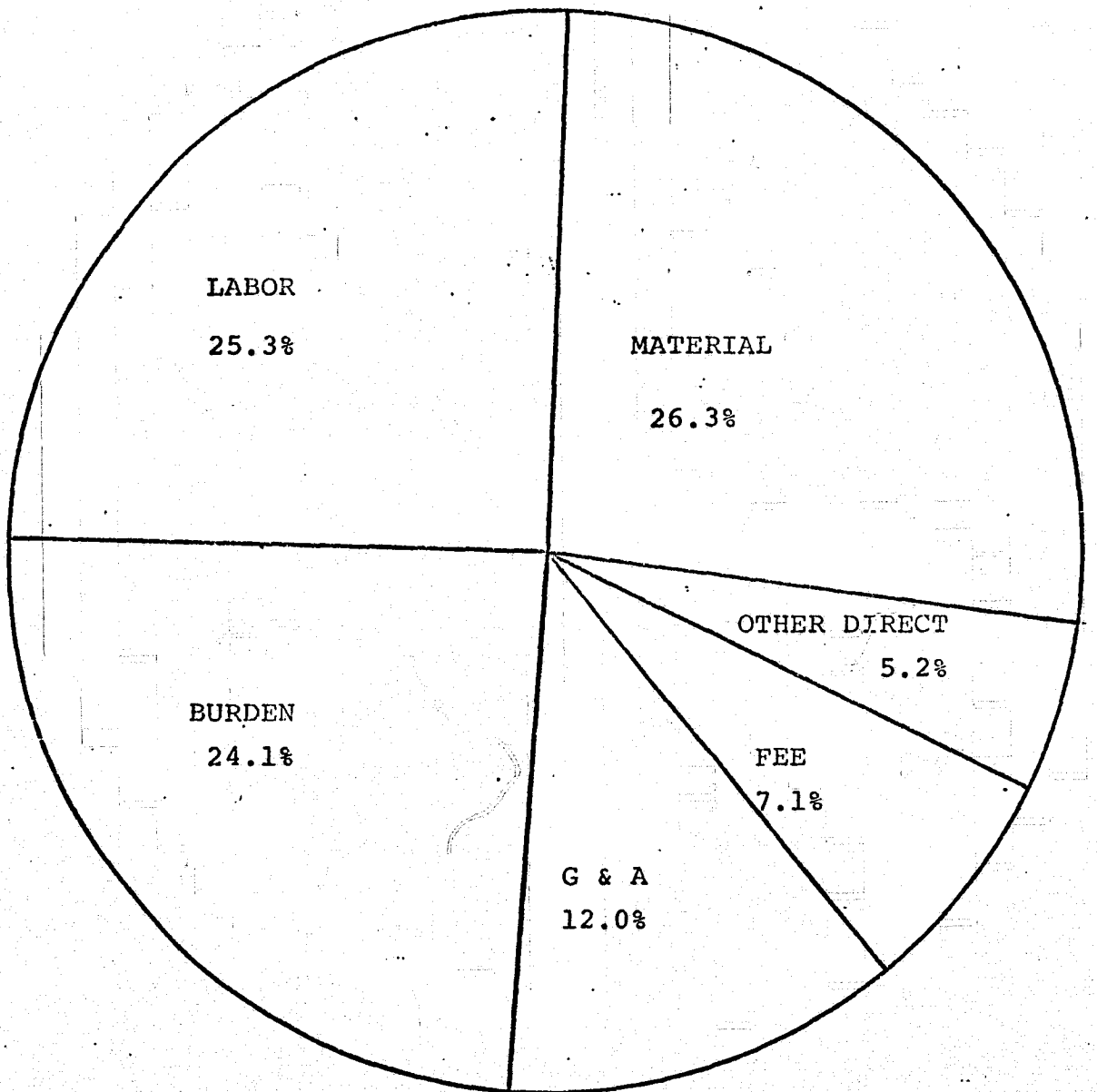
TABLE V



NAS 9-6100 TOTAL CONTRACT

PERCENTAGE OF COST BY COST ELEMENT

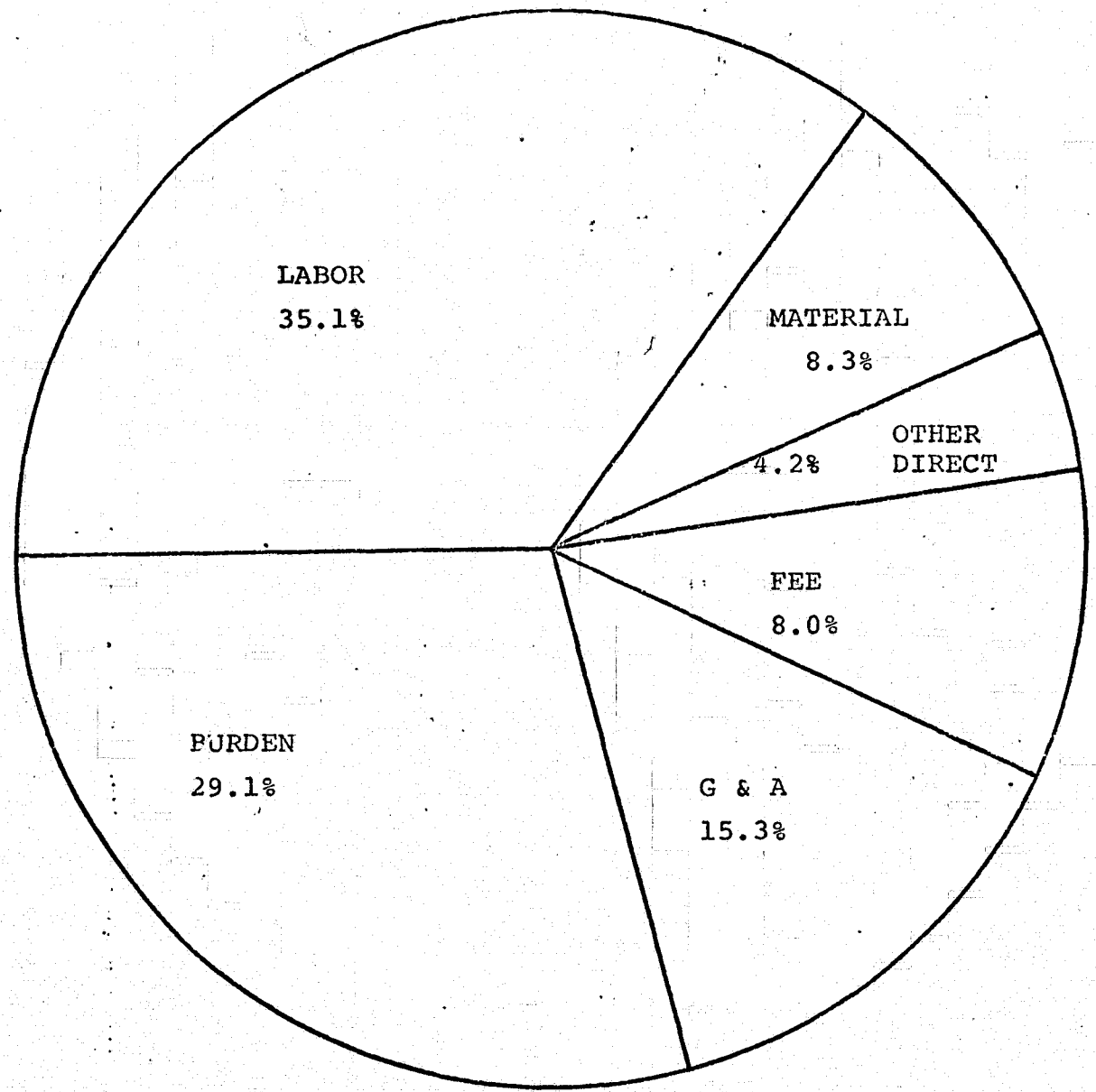
FIGURE 2a



NAS 9-6100 APOLLO 7-14 PHASE

PERCENTAGE OF COST BY COST ELEMENT

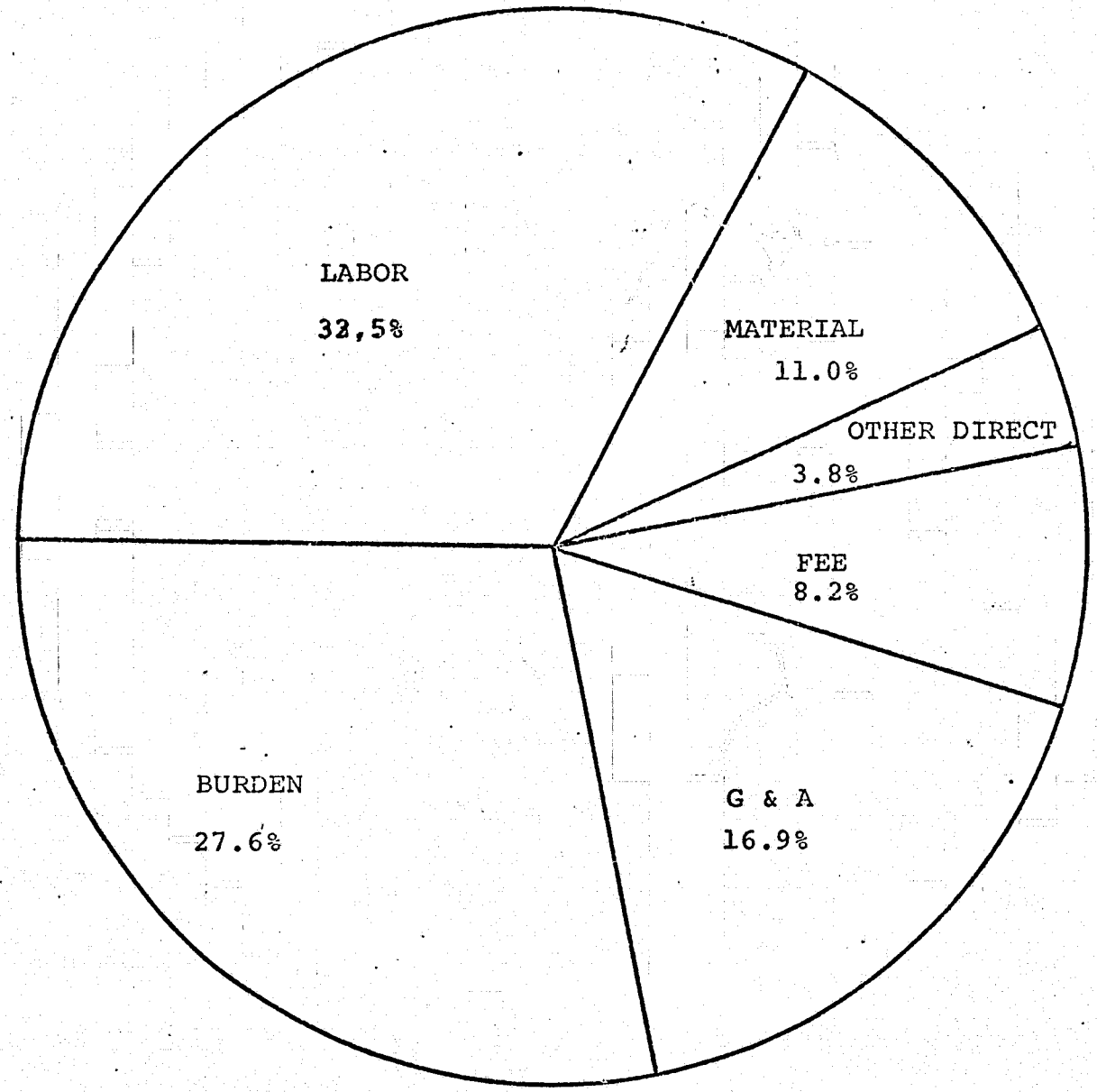
FIGURE 2b



NAS 9-6100 APOLLO 15-17 PHASE

PERCENTAGE OF COST BY COST ELEMENT

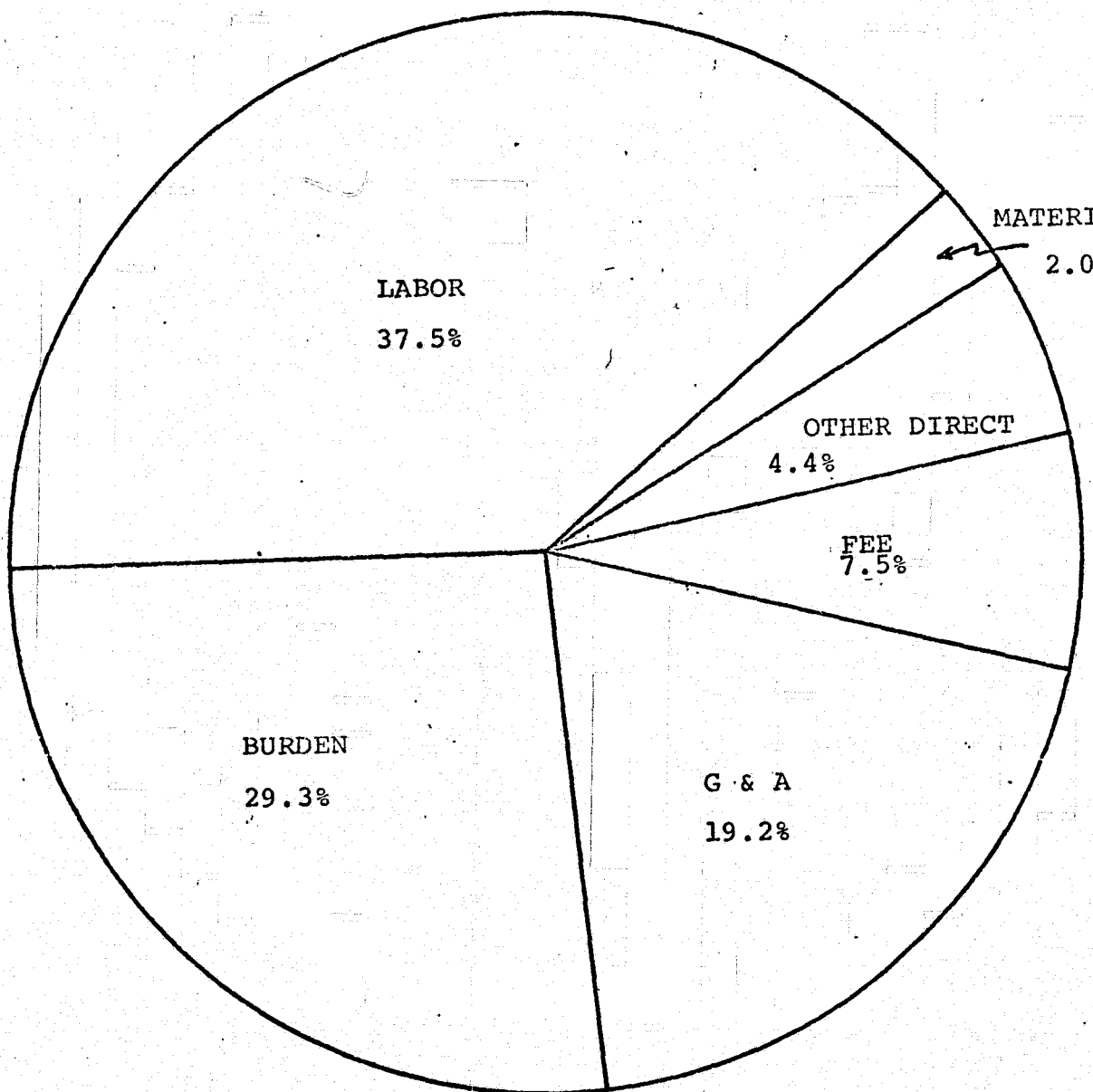
FIGURE 2c



NAS 9-6100 SKYLAB PHASE

PERCENTAGE OF COST BY COST ELEMENT

FIGURE 2d



NAS 9-6100 ASTP PHASE

PERCENTAGE OF COST BY COST ELEMENT

FIGURE 2e

MANHOURS:

GENERAL:

Manhour data has been compiled on the same contractural activity as cost data was compiled in the previous section. The program was divided into the same phases as the cost study but it was determined that a general organizational alignment would be the most suitable basis for analysis of the labor expenditure patterns of the program and the various phases. The general organizational groups (primary labor divisions) into which the labor was divided are:

- Manufacturing
- Engineering
- Program Management
- Quality Assurance and Reliability
- Field Support

All manhours expended over the performance period of the contract are segregated into the program phases and into the primary labor divisions stated above. Table VI shows the retionales used in segregating the data.

COMMENTS ON ANALYSIS OF MANHOURS DATA:

Table VII displays the compilation of the manhour data by phases by labor divisions. The charts shown in Figures 3 a through e depict the same data related as percentages of total manhours expended by phase and for the total contract.

Review of trends shown through the four phases lead to the following comments for each labor division:

Manufacturing - manufacturing labor in the Apollo 7-14 phase makes up a major portion of the manhours expended in the phase. This phase had the largest number of production suits as well as significant additional manufacturing labor for reasons explained in relation to Tables III and IV. Ensuing phases showed manufacturing labor as being a consistent percentage of the total.

Engineering - engineering labor was a consistent percentage through all phases except the Skylab phase, where it notably took up a greater percentage of the total. This was due to: 1) the small base of suits over which to prorate the development costs of the Model A7LB suit and 2) the mission support levels retained for contingencies through 1973, a full year beyond completion of the final Skylab production suit.

Program Mangement - program management maintained a consistent level of percentage of manhours through all phases, never varying more than four percentage points.

Quality Assurance and Reliability - Quality Assurance and Reliability also maintained a consistent level of manhours through all phases. A slight upward variation was noted during the Skylab phase. This is relatable to the same reason given in engineering, mission support levels being retained.

Field Support - field support labor was notably higher in the Apollo 15-17 and the ASTP phases. Field support was a function of the length of time over which the phase had to be supported. Both the Apollo 15-17 and the ASTP phase were quite extended periods of coverage.

APOLLO/SKYLAB/ASTP NAS 9-6100 (NAS 9-13698)

RATIONALE FOR SEGREGATING LABOR BY PRIMARY DIVISION BY PHASE

NO. OF SUITS PHASE	115 APOLLO 7-14		40 APOLLO 15-17		37 SKYLAB	9 ASTP
	SCHEDULE I	SCHEDULE II	SCHEDULE IVA	SCHEDULE IVB	SCHEDULES IVA & IVB	SCHEDULE IVB & NAS 9-13698
MANUFACTURING	-CEI's - Manufacturing functions; 50% of technician -Manufacturing Eng'g. -Quality Assurance & Reliability-Inspec. plus manufacturing functions -Spare Parts	-Field Support On Site manufacturing functions	822-Mfg. Functions Nov 69 thru May 71 -Mfg. Functions Jun 71 prorated to Apollo/Skylab on basis of suits delivered during period (13/31 Apollo) 825-Mfg. Functions Nov 69 thru Jun 71 827-Mfg. Functions Nov 69 thru Jun 71 824-Mfg. Functions Nov 69 thru Jun 71	832-Mfg. Functions Jul 71 thru Jun 72 prorated to Apollo/Skylab on basis of suits delivered during period (13/31 Apollo) 835-Jul 71 thru Oct 72 837-Jul 71 thru Nov 72 834-Mfg. Functions Jul 71 thru Nov 72	832-Mfg. Functions Jul 71 thru Jun 72 prorated to Apollo/Skylab on basis of suits delivered during period (18/31 Skylab) -Mfg. Functions Jul 72 thru Dec 22 822-Prorata share (See IVA) 835-Nov 72 thru Oct 73 837-Dec 72 thru Dec 73 834-Mfg Functions Dec 72 thru Dec 73	842 - All Labor 840 - Mfg. Engineering 835 - Nov 73 thru Dec 73
ENGINEERING	-CEI's-Engineering and Administrative functions plus 50% of technician -Program Mgmt.-Modelmaker & Photographer portion -Systems & Project Engineering -QA&R-Draftsman and photographer	Sustaining Eng'g - All Labor	820,821,823,828,829 - All labor thru May 71 less CCA 1000B 825- Engineering Functions Nov 69 thru Jun 71 827 - Engineering Functions Nov 69 thru Jun 71 824 - Engineering Functions Nov 69 thru Jun 71 822 - Eng'g Functions Nov 69 thru May 71 - Eng'g Functions Jun 71 prorated to Apollo Skylab on basis of suits deliv. during period (13/31 Apollo)	830,831,833,838 - All Labor Jul 71 thru Sep 71; Oct 71 thru Feb 72-50% Apollo 834-Engineering Functions Jul 71 thru Nov 72 832-Mission Support Jul 71 thru Jun 72 prorated to Apollo/Skylab on basis of suits delivered during period (13/31 Apollo)	820,821,823,828,829 - CCA 1000B; All labor Jun 71 830,831,833,838 - Oct 71 thru Feb 72 50% Skylab; Mar 73 thru Dec 73 all labor 834 - Engineering Functions Dec 72 thru Dec 73 832 - Mission Support Jul 71 thru Jun 72 prorated to Apollo/Skylab on basis of suits delivered during period (18/31 Skylab) 822 - Prorata share (See IVA) 840 - Jan 73 thru Apr 73 - All labor - May 73 thru Dec 73 estimated 50% Skylab/50% ASTP 836 - Dover portion of field support	846 - Age life testing; call tasks per projected expenditures 840 - May 73 thru Dec 73 estimate 50% ASTP/50% Skylab
PROGRAM MANAGEMENT	Program Mgmt - Labor functions engineer, draftsman, technician and secretary	Field Support - Onsite Labor Functions engineer, technician and secretary	819 - Prorata Share based on Apollo expenditures 826 - Dover Portion Field support Nov 69 thru Jun 71	839 - Prorata share based on Apollo	819/839 - Prorata shares based on Skylab expenditures	839 - Prorata share based on ASTP expenditures 846 - Program Mgmt. per projected expenditures

TABLE VI

NO. OF SUITS PHASE	115 APOLLO 7-14		40 APOLLO 15-17		37 SKYLAB	9 ASTP
	SCHEDULE I	SCHEDULE	SCHEDULE IVA	SCHEDULE IVB	SCHEDULES IVA & IVB	SCHEDULE IVB & NAS9-13698
QUALITY ASSURANCE & RELIABILITY	QA&R - Labor functions engineer, technician and secretary	-	822 - QA&R functions Nov 69 thru May 71 - QA&R functions Jun 71 prorated to Apollo Skylab on basis of suits delivered during period (13/31 Apollo) 825 - QA&R functions Nov 69 thru Jun 71 827 - QA&R functions Nov 69 thru Jun 71 824 - QA&R functions Nov 69 thru Jun 71	832 - QA&R Jul 71 thru Jun 73 prorated to Apollo/Skylab on basis of suits delivered during period (13/31 Apollo) 834 - QA&R Functions Jul 71 thru Nov 72	832 - QA&R Jul 71 thru Jun 73 prorated to Apollo/Skylab on basis of suits delivered during period (18/31 Apollo) 822 - Prorata Share (See IVA) 840 - Jan 73 thru Apr 73 - All labor - May 73 thru Dec 73 estimate 30% Skylab/70% ASTP 834 - QA&R functions Dec 72 thru Dec 73	840 - May 73 thru Dec 73 estimate 70% ASTP/ 30% Skylab
FIELD SUPPORT	-	Field Support-Offsite All Labor	826 - Field portion field support Nov 69 thru Jun 71	836 - Field portion Jul 71 thru Dec 72	836 - Field portion Jan 73 thru Dec 73	846 - Field Support projected expenditures

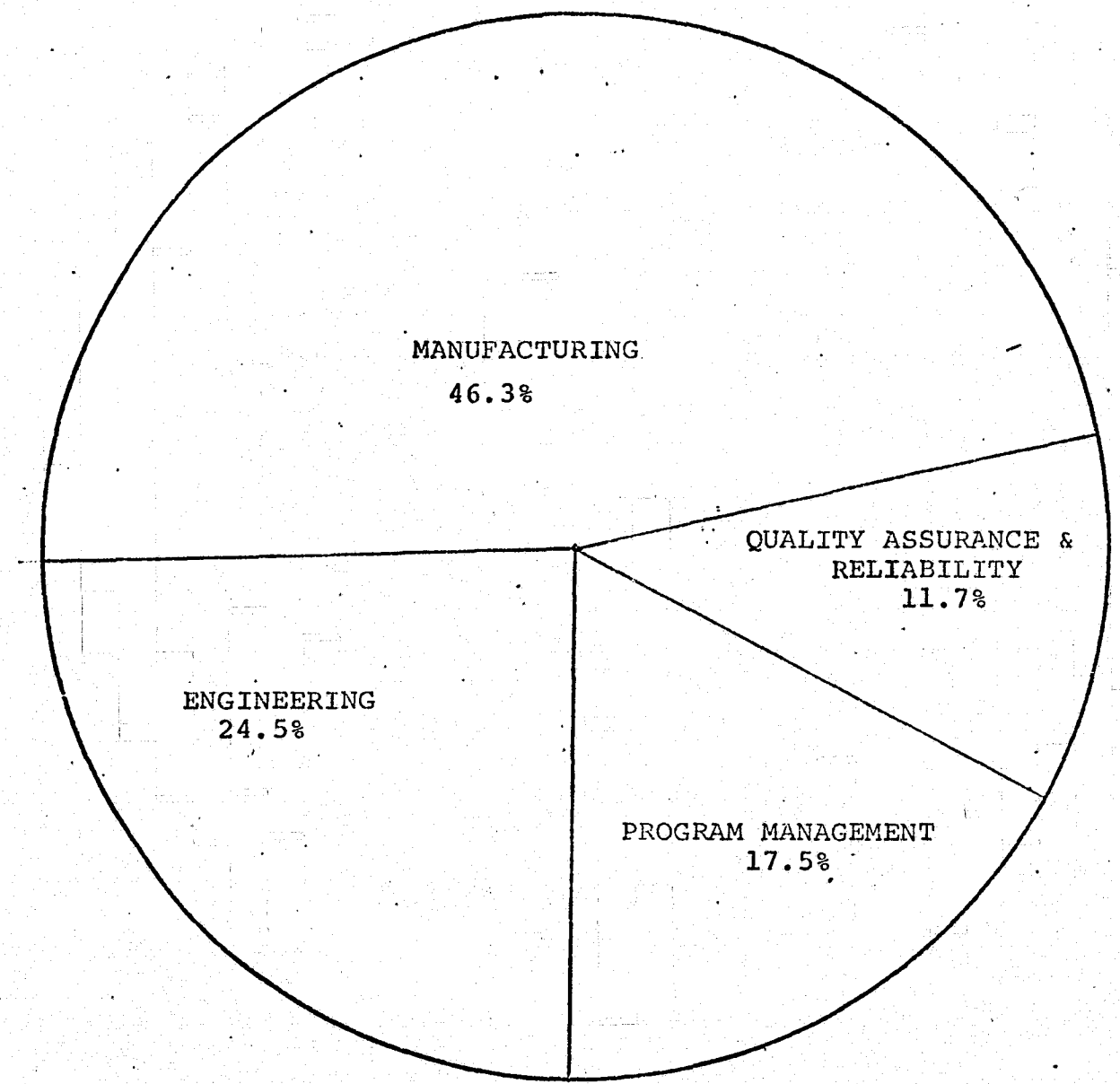
TABLE VI

APOLLO/SKYLAB/ASTP SUIT

NAS 9-6100 INCURRED COSTS BY GOVERNMENT FISCAL YEAR

	FY '66	FY '67	FY'68	FY '69	FY '70	FY '71	FY '72	FY '73	FY '74	FY '75 '76 '77	TOTAL
Production	493	3,039	3,914	5,093	2,928	2,311	2,761	1,219	416	-	22,174
Development	269	1,360	1,973	1,909	2,583	1,692	934	8	6	-	10,734
Mission Support	-	-	-	601	790	1,109	1,556	1,491	695	75	6,317
Program Management	366	1,292	1,200	1,437	1,980	1,261	1,132	902	577	71	10,218
Field Support	46	259	551	1,274	1,756	1,607	1,485	1,382	493	908	9,761
Maintenance Repair & Retrofit	4	45	61	62	189	386	245	127	12	-	1,131
Spares	15	127	221	926	372	211	148	237	31	3	2,291
TOTAL	1,193	6,122	7,920	11,302	10,598	8,577	8,261	5,366	2,230	1,057	62,626

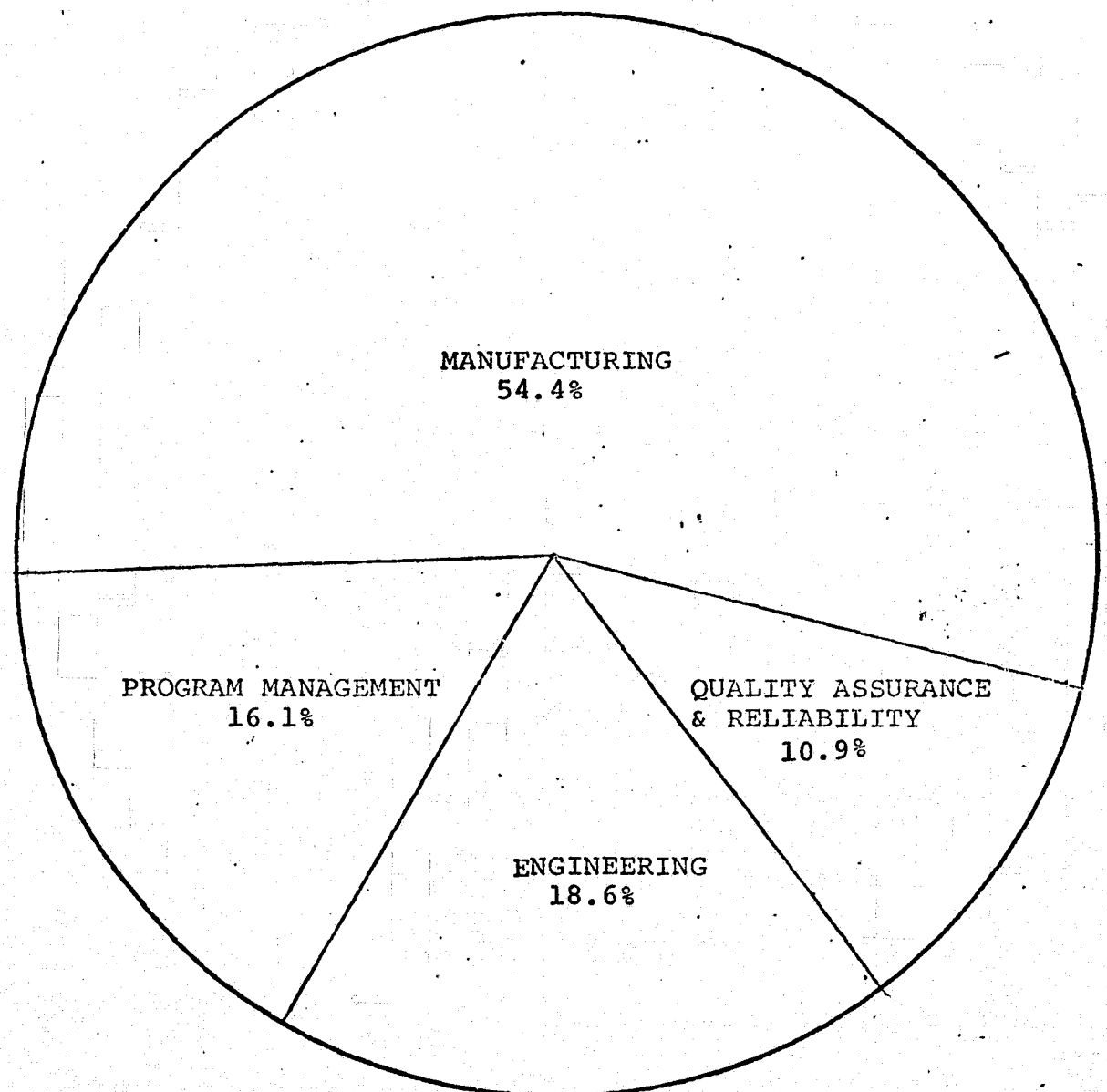
TABLE VIII



NAS 9-6100 TOTAL CONTRACT

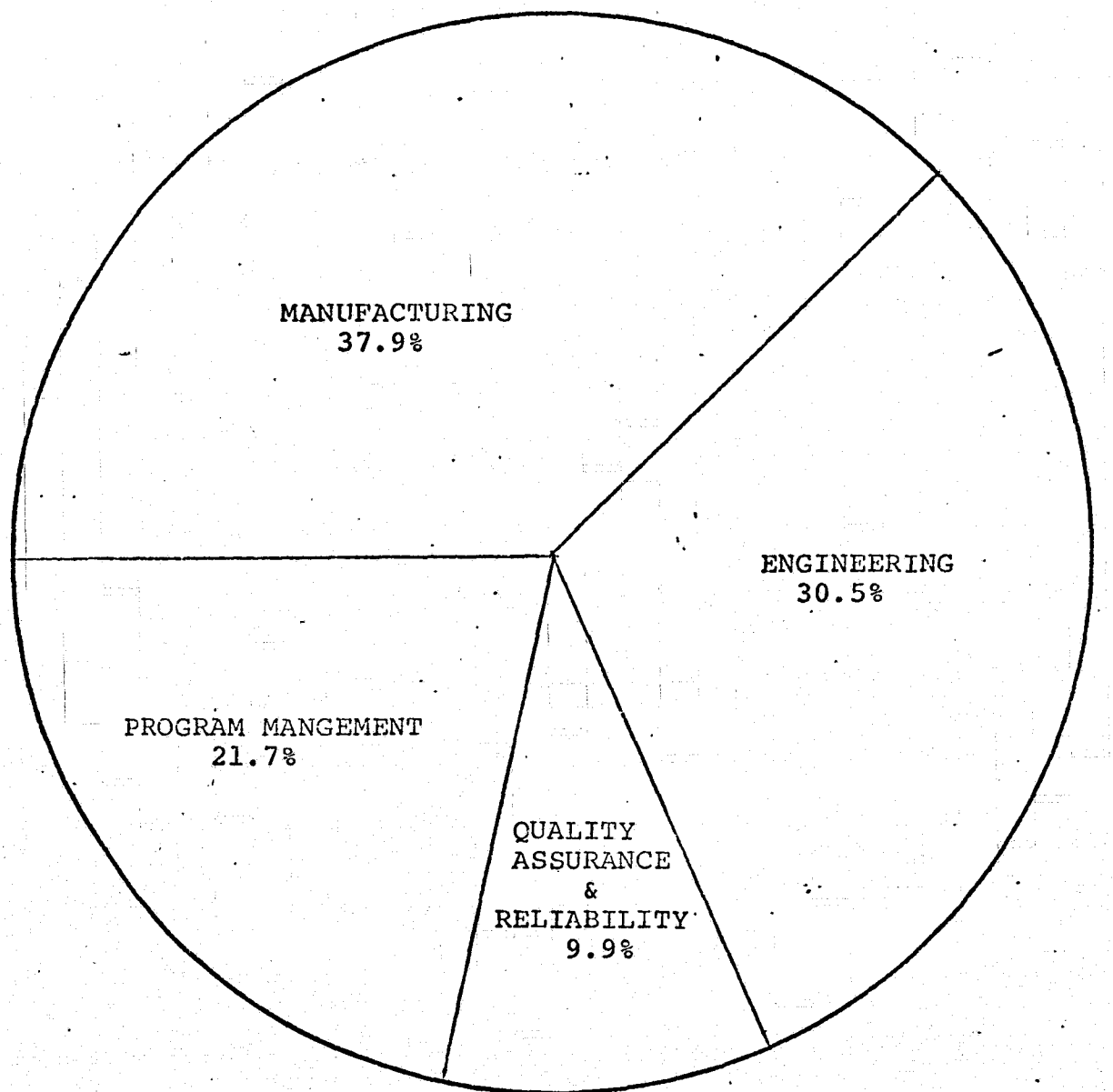
PERCENTAGE OF FACTORY LABOR BY PRIMARY LABOR DIVISION
(FIELD SUPPORT NOT INCLUDED)

FIGURE 3a



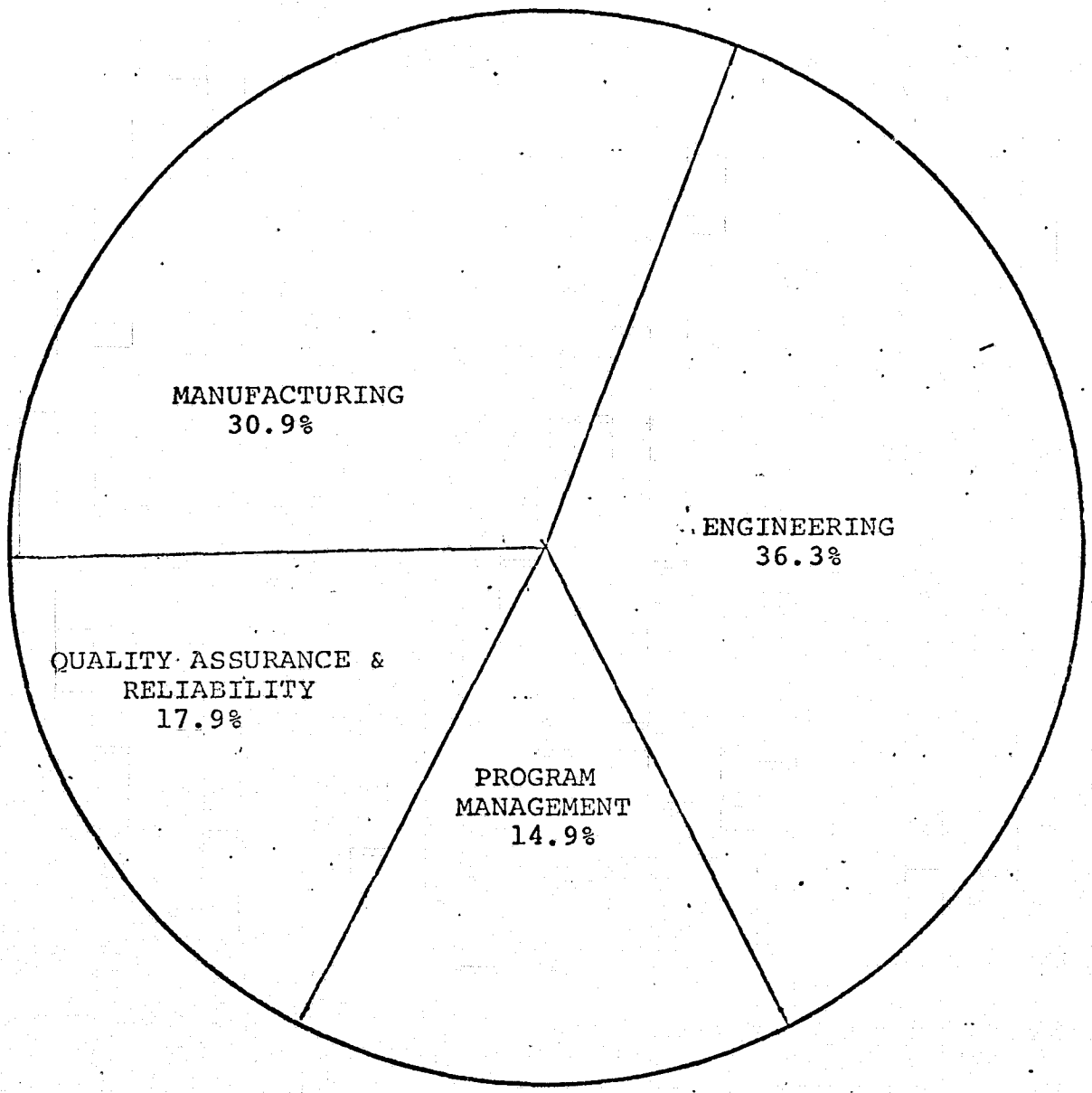
NAS 9-6100 APOLLO 7-14 PHASE
PERCENTAGE OF FACTORY LABOR BY PRIMARY LABOR DIVISION
(FIELD SUPPORT NOT INCLUDED)

FIGURE 3b



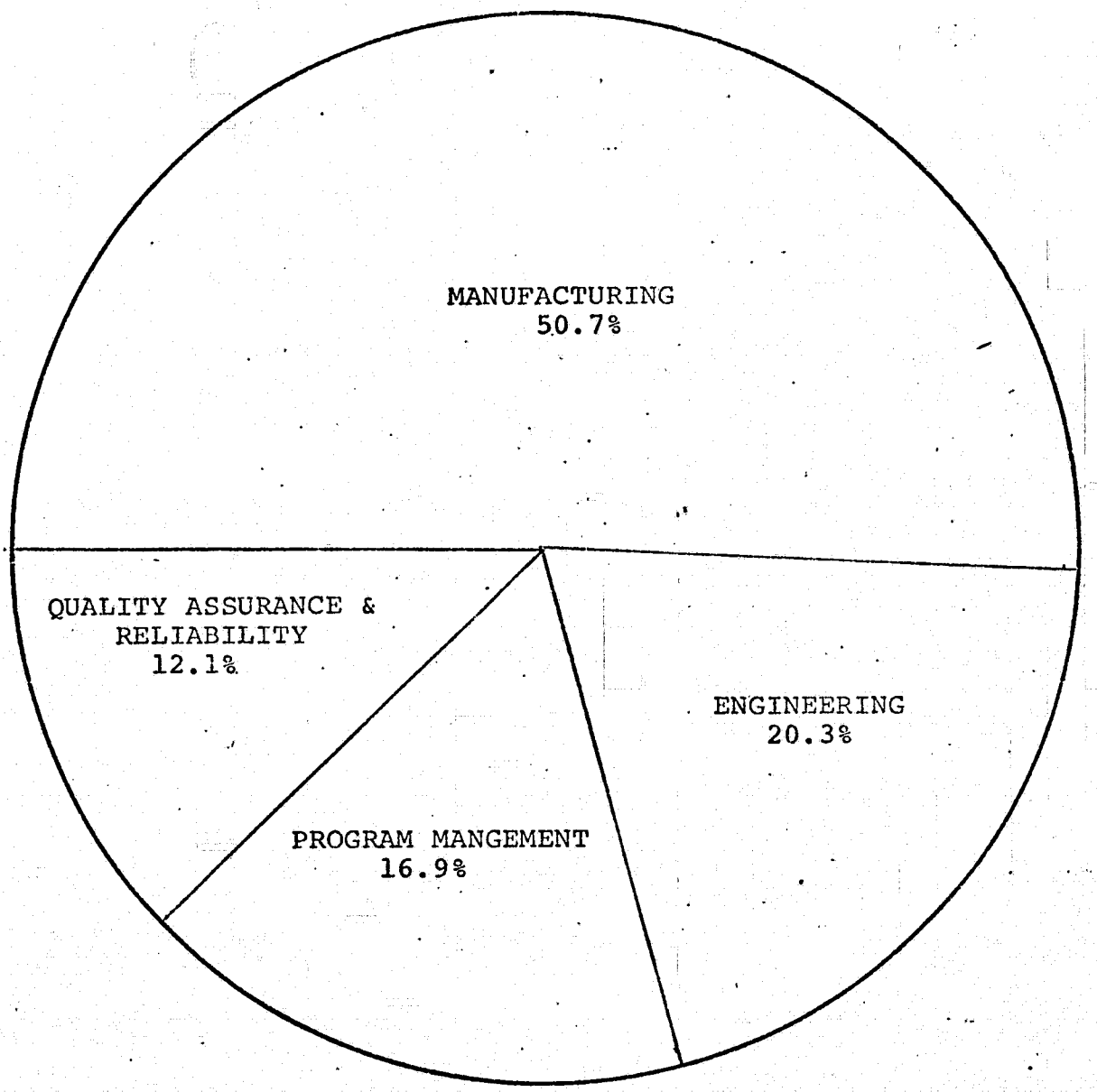
NAS 9-6100 APOLLO 15-17 PHASE
PERCENTAGE OF FACTORY LABOR BY PRIMARY LABOR DIVISION
(FIELD SUPPORT NOT INCLUDED)

FIGURE 3c



NAS 9-6100 SKYLAB PHASE
PERCENTAGE OF FACTORY LABOR BY PRIMARY LABOR DIVISION
(FIELD SUPPORT NOT INCLUDED)

FIGURE 3d



NAS 9-6100 ASTP PHASE
PERCENTAGE OF FACTORY LABOR BY PRIMARY LABOR DIVISION
(FIELD SUPPORT NOT INCLUDED)

FIGURE 3e

SCHEDULE:

Detail schedules of performance of this contract have been presented in other sections of this report. In this section, schedule information will be limited to summaries of suits delivered, actual delivery schedules for the suits and a schedule of significant qualification testing performed by the contractor.

Figure 4, Summary of Suits Delivered, summarizes first the contract vehicles under which the 201 suits delivered by ILC were procured and second the actual suits and types of suits delivered segregated by original mission assignment.

Figures 5 a through e are detail delivery schedules providing the actual delivery date of each suit delivered through the progress of the contract.

Performance dates and descriptions of qualification tests performed by ILC at the Dover facility are shown in Figure 6.

SUMMARY - SUITS DELIVERED

PROCUREMENT		DELIVERIES	
115	Schedule I	115	Apollo 7-14
	Schedule IV		
36	SA 333	77	Apollo 15-17 & Skylab
2	CCA 1000		
57	SA 433		
(18)	SA 565		
9	SA 586	9	ASTP
201	Total	201	

NUMBER OF SUITS DELIVERED

	SUIT NOS.	EV	IV-CMP	TOTAL
Apollo 7-14	A6L 001-025	25	-	25
	A7L 001-090	66	24	90
Apollo 15-17	A7L 091-096	2	4	6
	A7L 301-330	30	-	30
	A7L 401-404	-	4	4
Skylab	A7L 601-637	37	-	37
ASTP	A7L 801-809	-	9	9
Total		160	41	201

FIGURE 4

A6L PGA SUITS

S/N	DD-250 NO.	DATE
001	0011	7/11/66
002	0032	6340
003	0033	7060
004	0031	6347
005	0092	6329
006	0088	6327
007	0089	6343
008	0090	6327
009	0128	7048
010	0162	7/22/67
011	0184	10/4/67
012	0186	10/10/67
013	0254	1/26/68
014	0172	8/25/67
015	0176	9/1/67
016	0194	10/27/67
017	0129	7048
018	0173	8/29/67
019	0357	6/4/68
020	0174	8/29/67
021	0157	7/9/67
022	0233	1/3/68
023	0164	8/7/67
024	0189	10/13/67
025	0283	2/23/68

FIGURE 5a

A7L IV PGA (ITLSA)

S/N	DD-250 NO.	DATE
005	0377	6/8/68
008	0416	6/28/68
011	0429	7/3/68
017	0504	8/7/68
019	0500	8/5/68
025	0349	5/27/68
026	0442	7/15/68
028	0441	7/15/68
030	0558	9/24/68
033	1061	2/24/69
034	1299	5/13/69
037	0599	9/5/68
043	0802	11/19/68
048	0862	12/13/68
052	0801	11/19/68
055	1989	3/17/70
058	1458	7/8/69
059	1645	10/8/69
066	1052	2/24/69
069	1311	5/14/69
081	1332	5/22/69
082	1608	8/25/69
085	1496	7/17/69
088	1588	8/18/69
092	2011	3/20/70
094	2151	6/19/70
096	2187	7/7/70

A7L EV PGA (ITLSA)

S/N	DD-250 NO.	DATE	S/N	DD-250 NO.	DATE
001	0220	12/4/67	039	0922	1/10/69
002	0250	1/23/68	040	0727	10/22/68
003	0322	4/16/68	041	0726	10/21/68
004	0373	6/7/68	042	0742	10/26/68
006	0374	6/7/68	044	0775	11/10/68
007	0418	6/28/68	045	0856	12/13/68
009	0417	6/28/68	046	0928	1/10/69
010	0434	7/3/68	047	0995	2/5/69
012	0399	6/26/68	049	0900	1/3/69
013	0482	7/26/68	050	0959	1/24/69
014	0686	10/21/68	051	0774	11/7/68
015	0486	7/30/68	053	1149	3/27/69
016	0474	7/26/68	054	1035	2/19/69
018	0455	7/20/68	056	1003	2/11/69
020	0524	8/5/68	057	1100	3/11/69
021	0491	8/2/68	060	0939	1/24/69
022	0614	9/11/68	061	1123	3/18/69
023	0346	5/19/68	062	1720	10/6/69
024	0348	5/25/68	063	1130	3/19/69
027	0350	5/29/68	064	1573	8/25/69
029	0557	8/23/68	065	1157	4/1/69
031	0643	9/21/68	067	1143	3/28/69
032	0587	8/30/68	068	1297	5/10/69
035	0621	9/13/68	070	1244	4/29/69
036	0622	9/13/68	071	1773	11/4/69
038	0534	8/15/68	072	1791	11/10/69

FIGURE 5c

A7L EV PGA (ITLSA) - Cont'd

S/N	DD-250 NO.	DATE
073	1427	6/25/69
074	1091	3/9/69
075	1369	6/5/69
076	1090	3/9/69
077	1235	4/25/69
078	1599	8/21/69
079	1838	12/10/69
080	1354	5/29/69
083	1920	2/12/70
084	1524	7/29/69
085	1595	8/19/69
087	1675	9/17/69
089	1970	3/6/70
090	1936	2/13/70
093	2863	7/23/71
095	3500	5/30/72

FIGURE 5d

QUALIFICATION TESTS

PERFORMED AT CONTRACTOR'S FACILITY

Fluorel Boot Soles - A7L
Start 8/1/68
Finish 9/19/68

Mission "C" - IV Earth Orbital - A7L
Start 1/25/68
Finish 8/29/68

Mission "C" Prime - IV Earth Orbital - A7L
Start 10/15/68
Finish 10/22/68

Mission "D" - ITMG Qual - A7L
Start 11/12/68
Finish 12/12/68

Mission "G" - A7L Lunar Surface
Start 2/4/69
Finish 6/12/69

Mitchell Large Wrist Disconnect - Apollo 11
Start 3/13/69
Finish 3/17/69

Low Torque Arm Bearing - Apollo 11
Start 4/24/69
Finish 4/29/69

Boot Bladder, A7L - Apollo 13
Start 1/9/70
Finish 1/14/70

Arm Assembly and EV Gloves - Apollo 14
Start 9/22/70
Finish 10/14/70

A7L Redesigned Thigh Convolute Assembly - Apollo 14
Start 12/3/70
Finish 1/14/71

Mission "J" - Apollo 15
Start 9/21/70
Finish 6/25/71

Mission "J" - Apollo 16
Start 9/3/71
Finish 2/21/72

Figure 6

GENERAL CRITERIA

As part of this study, other general type information has been compiled. This general information has been gathered in this section. The general criteria included are:

- Apollo/Skylab/ASTP Suit NAS 9-6100 Incurred Costs By Government Fiscal Year - (Table VIII) - Costs have been compiled by major function and segregated into the government fiscal year in which they were incurred during the performance of the contract.
- Apollo/Skylab/ASTP NAS 9-6100 Subcontract Costs By Subcontractor By Year - (Table IX) - Payments to subcontractors employed by ILC in the performance of NAS 9-6100 have been gathered by calendar year. A brief description of items and services provided by each subcontractor is also shown.
- Schedule of Overhead and General and Administrative Rates - (Table X) - Overhead and G & A rates for the years 1966 through 1975, the years encompassed by this study, have been listed in this table for reference purposes. The 1966 through 1971 rates are negotiated and approval final rates. The 1972 through 1975 are provisional rates; 1972, 1973 and 1974 being approved provisional billing rates. 1975 rates are ILC established and at the time of this study had not received approval.
- CCA's Received per Month/SA's Received per Month - (Figures 7a and 7b) - These figures graphically depict the numbers of Contract Change Authorizations and Supplemental Agreements received over the span of the contract. Significant flight milestones and FACI dates are given. These dates, generally stated, are closely relatable to the level of change activity experienced.

MANHOURS BY PRIMARY LABOR DIVISIONS BY PHASE (IN 000'S)

Primary Labor Divisions	Apollo 7 - 14 Total Manhours	Apollo 7 - 14 % of Factory Total	Apollo 15 - 17 Total Manhours	Apollo 15 - 17 % of Factory Total	Skylab Total Manhours	Skylab % of Factory Total	ASTP Total Manhours	ASTP % of Factory Total	Total Total Manhours	Total % of Factory Total
Manufacturing	1082.9	54.4%	389.7	38.9%	160.0	30.9%	60.6	50.7%	1693.2	46.3%
Engineering	370.2	18.6	313.1	30.5	187.6	36.3	24.3	20.3	895.2	24.5
Program Management	319.8	16.1	223.6	21.7	76.9	14.9	20.2	16.9	640.5	17.5
Quality Assurance & Reliability	217.1	10.9	101.7	9.9	92.5	17.9	14.5	12.1	425.8	11.7
Factory Subtotal	1990.0	100.0%	1028.1	100.0%	517.0	100.0%	119.6	100.0%	3654.7	100.0%
Field Support	409.2		519.6		111.0		67.2		1107.9	
TOTAL	2399.2		1547.7		628.9		186.8		4762.6	
No. of Suits	115		40		37		9		201	

TABLE VII

APOLLO/SKYLAB/ASTP NAS 9-6100

SUBCONTRACT COSTS BY SUBCONTRACTOR BY CALENDAR YEAR

Subcontractor	1966 & 1967	1968	1969	1970	1971	1972	1973	Total Per Sub-Contractor	General Listing of Items Subcontracted
Airlock Inc.	-	1,008,137	747,381	346,952	403,176	458,383	78,069	3,042,098	Hardware, Helmets
LTV Aerospace	1,526,380	675,651	239,465	252,123	570	<3,689>	-	2,690,500	Engineering Support, LEV
Prodesco	-	115,298	97,186	38,625	76,119	37,476	2,720	367,424	Chromel-R
Perkin-Elmer	-	124,555	178,041	13,096	-	7,163	-	322,855	EVVA Coating
B. Welson	-	73,120	36,913	31,332	64,334	90,995	23	296,717	LCG's
Cicoil	-	84,480	126,843	48,287	21,121	101	-	280,832	Electrical Harness
Dynamagnetic	-	89,089	69,621	18,508	19,452	22,934	-	219,604	Pressure Gages
Raybestos Manhattan	-	63,911	15,842	10,303	12,471	16,555	4,625	123,707	Fluorel
Stern & Stern	-	32,856	25,214	19,146	33,973	6,335	4,159	121,683	Cloth
Thiokol	-	40,301	18,970	-	-	-	-	59,271	CNR
Texstar Plastic	-	17,080	12,448	420	310	-	-	30,258	Helmets
B. F. Goodrich	-	7,753	7,541	-	1,519	3,807	5,111	25,731	Zippers
Stockwell Rubber	-	15,969	127	170	-	-	-	16,266	Mold Tooling
Whirlpool	-	9,902	2,643	-	-	-	-	12,545	FCS
David Clark	-	412	-	-	-	-	-	412	Zippers and Tapes
TOTAL SUBCONTRACT PER ANNUM	1,526,380	2,358,514	1,578,235	778,962	633,045	640,060	94,707	7,609,903	

TABLE IX

SCHEDULE OF OVERHEAD

AND GENERAL AND ADMINISTRATIVE RATES

1966 THRU 1975

	OVERHEAD	G & A
1966 (Fiscal Year)		
Dover	126.79%	15.25%
Field	25.00%	15.25%
1967 and 1968[1]		
Dover	105.04%	14.04%
Frederica	120.85%	14.04%
Field	25.00%	14.04%
1969		
Dover	111.06%	15.08%
Frederica	144.37%	15.08%
Field	25.00%	15.08%
1970		
Dover	120.0%	21.3%
Frederica	201.4%	21.3%
Field	25.0%	21.3%
1971		
Dover	106.0%	20.8%
Field	25.0%	20.8%
1972[2]		
Dover	98.0%	22.75%
Field	25.0%	22.75%
1973[2]		
Dover	115.0%	23.5%
Field	25.0%	23.5%
1974[2]		
Dover	160.0%	30.0%
Field	33.0%	30.0%
1975[2]		
Dover	160.0%	30.0%
Field	34.0%	30.0%

NOTES:

1. Change from fiscal year to calendar year.

2. Provisional rates.

TABLE X

FIGURE 7a

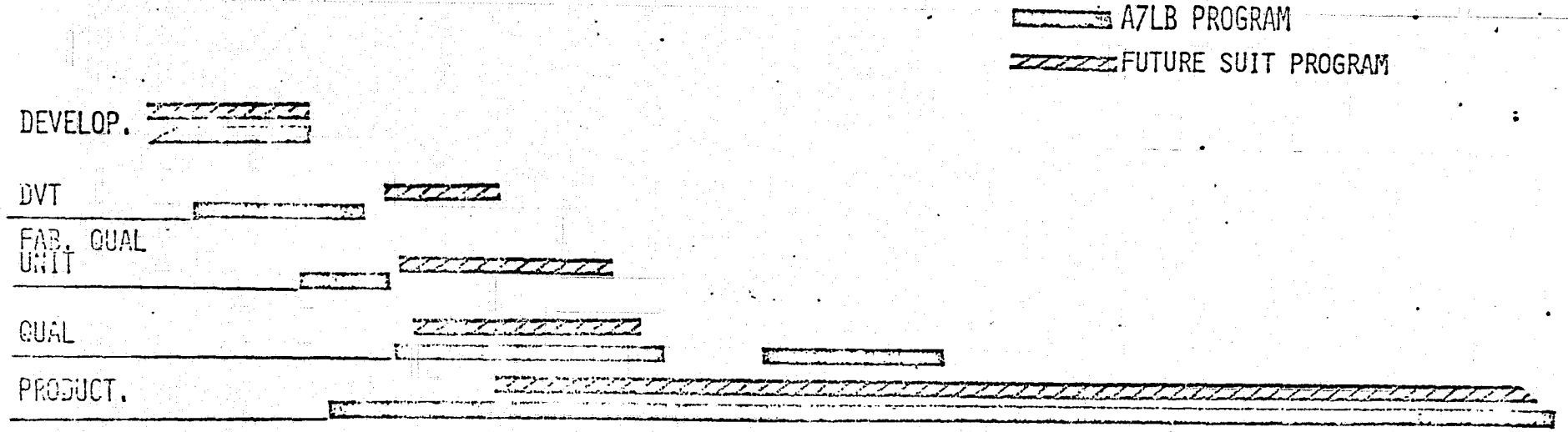
ORIGINAL PAGE IS
OF POOR QUALITY
CCA'S RECEIVED PER MONTH
CCA'S PER MONTH
48
44
40
36
32
28
24
20
16
12
8
4
0
1966
1967
1968
1969
1970
1971
1972
1973
FLIGHTS
APOLLO 7, OCT 11-22
APOLLO 8, DEC 21-27
APOLLO 9, MAR 3-13
APOLLO 10, MAY 18-26
APOLLO 11, JUL 16-24
APOLLO 12, NOV 14-24
APOLLO 13, APR 11-17
APOLLO 14, JAN 31-FEB 9
APOLLO 15, JUL 26-AUG 7
APOLLO 16, APR 16-27
APOLLO 17, DEC 7-19
SKYLAB 1
SKYLAB 2
SKYLAB 3
FACI'S
A5L MAR 1
A6L NOV 29
A7L SEP 10
A7LB JUN 12
SL MAR 1
SL RED OCT 19

FIGURE 7b

MATRIX OF WORK BREAKDOWN STRUCTURE (MAJOR FUNCTIONS) WITH PRIMARY LABOR DIVISIONS

WBS LEVEL 0 1 2	PROGRAM MANAGEMENT			ENGINEERING				MANUFACTURING			QUALITY ASSURANCE & RELIABILITY				FIELD OPERATIONS		
	PROGRAM CONTROL	RESOURCES CONTROL	CMO	SYSTEMS ENGINEERING	DESIGN ENGINEERING	TEST ENGINEERING	PROJECT ENGINEERING	FABRICATION	INSPECTION	MANUFACTURING ENGINEERING	QUALITY ENGINEERING	RELIABILITY	TECHNICAL SUPPORT	DOCUMENTATION	JSC	KSC	OTHER
Space Suit Program																	
Program Management																	
Management	X																
Program Control	X																
Resources Control		X															
Configuration Mgt.			X														
Design																	
Individual Design Tasks				X	X	X	X	X		X	X	X	X				
Component Development																	
Prototype Fab.								X	X	X							
Design Verification Testing					X	X	X										
Qualification Testing					X	X	X				X		X	X			
Engineering Tasks																	
Individual WRF Tasks					X	X	X	X	X								
Production																	
CEI's								X	X								
Manuf. Engineering										X							
Mission Support																	
Engineering				X	X	X	X										
Quality Assurance											X		X	X			
Reliability												X					
Retrofit & Repair																	
Depot Retrofit								X	X	X							
Mod. Kit Fab.								X	X	X							
Maint. & Repair WRF's								X	X								
Spares																	
Individual Spares Orders								X	X	X							
Field Support															X	X	X

EXHIBIT I



APOLLO/SL/ASTP

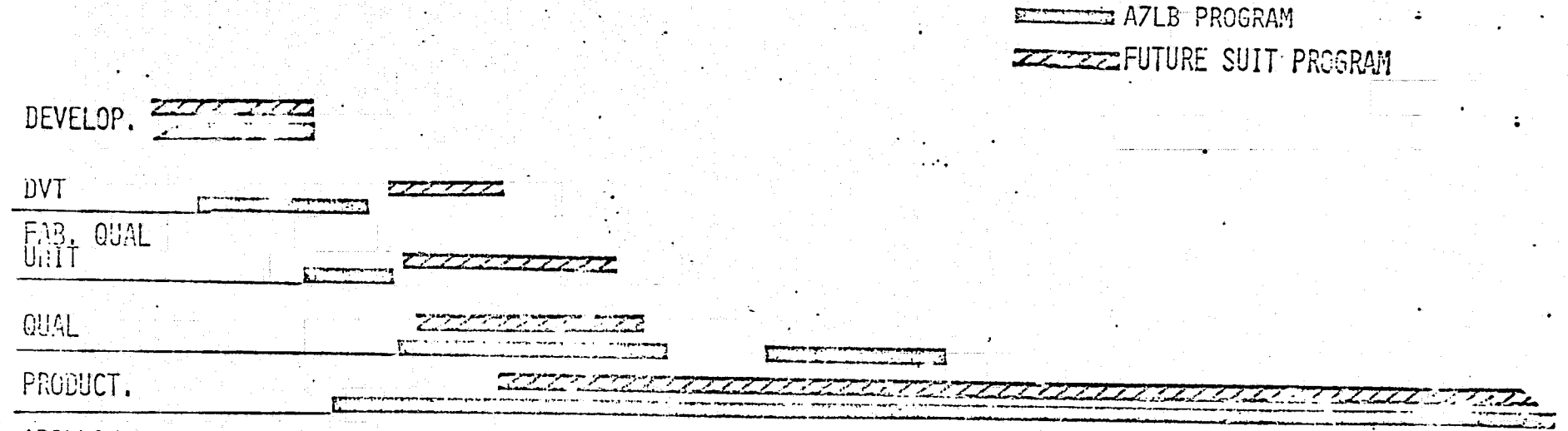
YEAR	1970				1971				1972				1973			
QUARTER																
LEVEL FACTORED FOR 1/20	24	84	77	69	78	94	90	85	80	72	68	57	48	48	48	48

FUTURE PROGRAM

YEAR	1ST				2ND				3RD				4TH			
QUARTER	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
PROPOSED LEVEL	57	59	60	63	63	58	40	28	24	24	24	24	24	24	24	24
NET REDUCT.	27	25	17	6	15	36	50	57	56	48	44	35	24	24	17	24

ENGINEERING MANNING SUMMARY
ENGINEERS (MAN MONTHS)
REDUCTION 485

FIGURE 4.4.3



APOLLO/SL/ASTP

YEAR	1970				1971				1972				1973			
QUARTER																
LEVEL FACTORED FOR 1/20	42	52	49	46	54	48	38	38	36	33	32	29	29	29		29

FUTURE PROGRAM

YEAR	1ST				2ND				3RD				4TH			
QUARTER	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
PROPOSED LEVEL	37	45	48	43	49	43	27	21	17	17	17	17	17	17	17	17
NET REDUCT.	5	7	1	3	5	5	11	17	19	16	15	12	12	12	12	12

ENGINEERING MANNING SUMMARY
SUPPORT PERSONNEL
REDUCTION 164 MM

FIGURE 4.4.3